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CONTENTS

VOLUME 66 • NUMBER 2

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On-Site

Innovation, Customization & Sustainability: How FlexFilms Focuses on U.S. Market

Global player in BOPET film has big plans for U.S. market with innovative products developed collaboratively with customers while paying heed to environmental concerns.

By Jim Callari, Editorial Director

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Make Your Mark in *Plastics Technology*'s 'Top Shops' Survey

Benchmark your injection molding operation by being a part of our annual survey. Learn more about "best-in-class" practices that separate the top shops from the rest.

Jim Callari
Editorial Director

If you're an injection molder, you're going to be hearing a lot from us in the coming weeks about our annual Top Shops survey. You'll receive gentle nudges in our e-newsletters and blog postings—and through social media—about the study. You'll also be receiving reminders from us in the mail.

We published the results of our Top Shops 2019 survey in our October issue, in an article written by Senior Editor Tony Deligio, who heads up this project. In the months since that article was published, I have received numerous emails and phone calls from molders who wished they had participated in that study, but somehow missed it. We want to make sure that doesn't happen again.

Sure, most molders nowadays have metrics they use to measure their operation's efficiency. But these metrics are held within the four walls of their operation. You may think you have a best-in-class operation, but do you really know unless you have some sense as to what "the other guys" are doing? You may have a "best practices" standard against which you measure yourself, but what if it falls short against your competition?

That's what Top Shops is all about. *Plastics Technology* is endeavoring to help you answer that question—how you stack up against your competition—with its Top Shops Program, which has evolved from the former World Class Processors benchmarking study. Unlike its predecessor, Top Shops focuses specifically on injection molding. It's a comprehensive online survey that will let you see just how you stack up across multiple metrics versus other injection molding facilities. All survey data are kept 100% confidential.

So how does this all work? The first part is easy. Go to ***survey.ptonline.com/topshops*** to start. We'll be asking you to provide demographic data, as well as information on some key performance metrics such as sales growth, sales per machine and employee, scrap rate, and setup time, among others. Scoring on 10 of these metrics is used as a means to separate Top Shops from the rest of the respondents. Depending on what your job is at your company, you may need assistance from some of your colleagues to answer some of the questions, but I'm confident you will find it worth the effort.

This October, Tony will once again report on the results of the study. But if you participate, you will also get a customized report showing you how the key metrics you track—machine utilization, on-time delivery, scrap rate, mold-change time and more—compare with the molders you compete against. I think there is a lot of value in knowing how your facility stacks up against others, apples-to-apples. Is your competition doing more training than you? Are they offering more in the way of value-added services? Have they figured out innovative ways to automate? Do they provide additive manufacturing services beyond prototyping? Have they expanded their toolroom to include mold building in addition to repair? Do they invest in technology even when business is less than robust?

Let's say you do participate in this study and wind up being acknowledged as a Top Shop. What then? My answer: Market it. If I were ranked a Top Shop molder, I'd ask the folks at *Plastics Technology* Magazine for the logo at left to post on my website along with a link to the article. I'd put that logo on my letterhead, on the forms I use for RFQs, on my sales collateral. I would make sure all of my salespeople included that logo in any PowerPoint presentation they gave.

Top Shops for years has been a research staple of sister publications such as *Modern Machine Shop* and *Products Finishing*. A *Products Finishing* honoree once put the logo on all of its trucks. Kind of clever, I think. Maybe you can do better.

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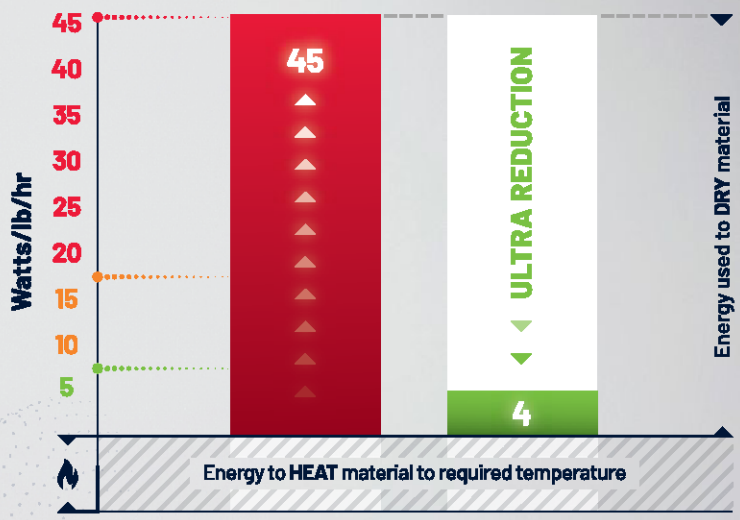

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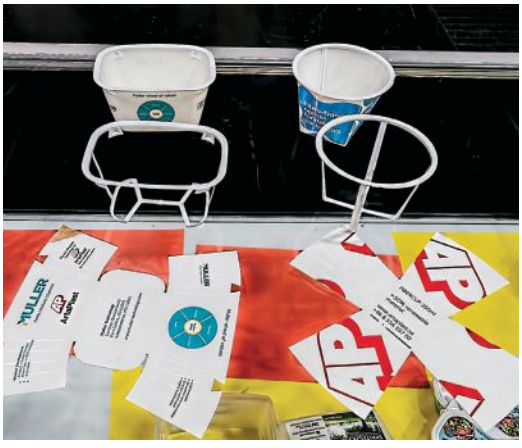
Paper IML Trims PP Tub to a Skeleton

A novel packaging concept exhibited at October's K 2019 fair in Düsseldorf promises to cut costs and perhaps environmental footprint. Displayed by Swiss-based Muller Group (formerly Mold & Robotics Group), specialists in molds and automation for thin-wall packaging and in-mold labeling (IML), this concept eliminates 76% of the PP in an injection molded tub, replacing it with a thick paper label that becomes the structural sidewall. According to Taras Konowal, director of sales and marketing for packaging automation provider Muller Technology Colorado (formerly CBW Automation), this approach not only saves money on PP resin, but the paper label is also much less expensive than a plastic in-mold label. What's more, topload strength is actually increased by this construction, he says (***muller-technology.com***).



Two commercial applications of this concept—for cottage cheese and yogurt—have been launched in Europe by Arta Plast of Sweden (***artaplast.se***). The label was supplied by Stora Enso of Finland and Sweden (***storaenso.com***). Its Fiber Cup material is paperboard coated on both sides with a thin layer of PP. It contains >50% renewable material, according to Stora Enso, and is described as "recyclable." IML experts interviewed at K 2019 questioned whether the overall IML package would more appropriate for the paper or plastic recycling stream.

Chinaplas Returns to Shanghai in April

The 34th Chinaplas fair will be staged April 21-24 at the National Exhibition and Convention Center in the Hongqiao sector of Shanghai. The annual show, which rotates between Guangzhou in southern China and Shanghai in the country's center, was last in Shanghai in 2018, when it was staged at for the first time at the new exhibition center.

That show covered 3.6 million ft² and had 3964 exhibitors, drawing 180,701 visitors. Adsale Exhibition Services Ltd., organizer of Chinaplas, is again anticipating more than 3900 exhibitors at Chinaplas 2020, including more than 2500 from China. There will also be 11 country/region pavilions, representing Germany, Italy, the U.S., Japan and others, as well as 19 themed zones. Chinaplas 2019 in Guangzhou set a new record for the show in that city, featuring 3622 exhibitors and 163,314 visitors.

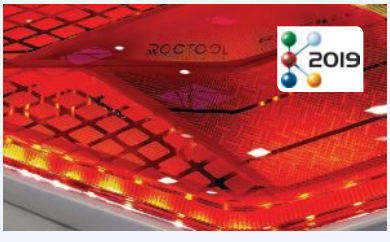
Guill Launches 10-Day Extrusion Tooling Program

Guill Tool & Engineering has announced a new extrusion tooling program in which certain tips and dies will be shipped to processors within 10 business days after receiving the purchase order. Eligible tips and dies for this program cannot be plated and must have a diameter less than 1.5 in. and a length less than 4.75 in.

All Guill extrusion tools are produced using certified and documented quality steel material specifically qualified for the polymer to be extruded. Available tips include single and multi-lumen, threaded, snap-together, fixed center shoulder, profile, tapered and custom. To find out which tools are eligible for the program, customers can check with any sales representative. For all other parts, company personnel will review the customer's drawing to determine whether it is eligible for the program.

Induction Heating Offers Potential in Auto Lighting

At the recent K 2019 fair in Germany, Roctool showcased a new area of application development for the company's induction-heating technology: automotive lighting. Induction heating excels in creating extremely fine tool-surface replication in molded parts via the hot/cold ("Variotherm") molding technique. In the case of auto lenses, complex laser-applied mold textures for the rear surface of the part are designed to optimize the light path and intensity in different



zones of the lens. The accompanying photo shows the excellent replication of textures in a taillight lense—better than with conventional molding, according to Roctool CEO Mathieu Boulanger.

At K, Boulanger also noted that Roctool has introduced a new generator that is much more compact than previous units. Available in 25 and 50 kW models, it is now cooled with air instead of water.

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Toray Develops Game-Changing PPS Film for 5G Flexible Printed Circuit Boards

Japan's Toray Industries (U.S. office in N.Y.C.) has created what appears to be the first PPS (polyphenylene sulfide) film designed specifically for 5G flexible printed circuits. Said to be revolutionary, Torelina is biaxially oriented PPS film that maintains outstanding dielectric characteristics, flame retardancy and chemical resistance at 40° C/72° F higher than conventional counterparts. The new film resists deformation and is dimensionally stable near its crystalline melting point of 280 C/536 F.

Toray has finalized testing of the new film on a pilot basis, and looks to have mass production in place this year for the fast-expanding 5G arena. Flexible printed circuits are film-like wiring boards in which electrical circuits are formed on base materials from bonding thin, soft insulating base films with copper foil or other conductive metals.

LCP (liquid crystal polymer) films have emerged as flexible printed-circuit substrates for 5G. Though they offer good dielectric properties and high heat resistance, the high cost and processing issues of LCP films fueled the exploration of other materials that could overcome those shortcomings.

Toray says PPS film offers superior flame retardancy and chemical resistance while matching or exceeding the dielectric properties of LCP, and is far less vulnerable to temperature and humidity extremes. However, conventional PPS film deforms easily at high temperatures and provides insufficient heat resistance when soldering circuit boards. This drove Toray to develop a proprietary technology that controls the crystal structure of PPS films and dramatically increases heat resistance.

Testing at up to 250 C/482 F confirmed that Toray's new PPS film does not deform, which should suit it to existing processing facilities for circuit boards. Toray attained a low coefficient of thermal expansion in the thickness direction of 98 ppm/°C by controlling molecular orientation.

New North American Office & New Presses for Bole Machinery

Bole Machinery, one of the largest producers of injection molding machines in China, has established a new North American headquarters in Stow, Ohio. Headed by Alfred Rak, president and CEO, Bole Machinery Inc. (***boleamerica.com***) provides a central showroom for machine trials, along with a team of U.S. service engineers and parts-exchange service for older machines. Bole supplies six main lines of machines from 70 to 6800 tons, including two-platen, servohydraulic, and all-electric series. Three-axis robots are available with its machines. Major industries served include automotive, home appliances and industrial markets.

At last fall's K 2019 show in Germany, Bole showed off two new developments. One was a new, smaller size (520 metric tons) in its German-engineered BL servohydraulic two-platen line, which ranges up to 2000 m.t. The other is the EKS series of servohydraulic toggles from 280 to 4000 m.t. (photo). They boast more than 60 upgrades in mechanical, electrical, hydraulic, and software systems, as well as the assembly process.

A key feature is the central clamping toggle, said to provide reduced mold/platen deformation and 100% utilization of clamp force at mold edges, vs. 80-85% for other machines. Other claimed benefits are better mold protection and larger opening stroke. These machines are also said to be ready for Industry 4.0—able to extract information from auxiliary equipment such as robots, mold-temperature controllers and cooling water. An MES data-exchange terminal is also available.

New Supplier of Color, Additives & Purging Compounds

A relative newcomer to the arena of colorants, additives and purging compounds for thermoplastics offers a broad range of products based on new technologies. Britec Solutions Inc., Tyler, Texas (***britecsolutions.com***), was founded in 2010 as a consulting and product-development firm. According to company president Brian Cochran, Britec provided technical support to some of leading players in the plastics industry. This included delivery of innovative technologies in liquid color, purging compounds and additives.

In mid-2019, Britec began its own manufacturing and marketing of its Britec liquid systems, BritePurge high-performance purging compounds, BTec PET performance and processing additives, and BTec polymer additives. The liquid systems consist of custom liquid colorants, single-pigment dispersions, and additives that include BTec polymer additives.

The BTec PET performance and processing enhancers include toners for recycling, IV enhancers and denesting and process aids. BTec polymer additives utilize a proprietary compounding process to manufacture a wide range of highly concentrated pellet masterbatches. Included are foaming agents, flame retardants, UV stabilizers, antioxidants, processing aids, and slip, release, nucleating and antimicrobial agents.

BritePurge's product line includes an FDA-compliant liquid purge compound and a concentrated chemical purging agent for any resin, as well as ready-to-use chemical and mechanical/non-abrasive purge compounds for polyolefins, PS, PET/PETG, styrenics, PC, nylons and acetals.

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Bigger, Faster, Lower-Cost Robots at K 2019

Three, four, five and six axes; high speed and high payload capacities; low-cost models; and collaborative robots made news at K.

By Matthew Naitove
Executive Editor

More power and more speed were the key themes of robot exhibits at the Düsseldorf show in October. "Less" was a contrasting theme: less upfront investment and lower operating costs, less space occupied, less safety guarding required, and less complexity in programming. Some systems were specialized for structural composites, IML, medical pipettes, and single-use coffee capsules. (An expanded version of this report, with additional details and product coverage, is available at ***ptonline.com***.)

CARTESIAN ROBOTS PUSH THE ENVELOPE

On the "more" side, Arburg introduced a new size of linear robot, the Multilift V30 for large Allrounder presses (250 to 650 metric tons). It can heft 30 kg (66 lb).

Yushin also went big with its new MKA-2000S servo robot for machines of 1500 tons and larger. It handles loads of 66 to 110 lb with a traverse ("X") axis of 4000 to 5000 mm and two-stage, telescoping vertical ("Z") axis of 2500 to 3000 mm. Compared with previous Yushin large robots, the new model boasts 17% shorter takeout times and 10% faster overall dry cycles.

Engel introduced viper linear robots with longer strokes and other enhancements (see September show preview).

Wittmann Battenfeld brought out its new Sonic line of robots said to be 60% to 70% faster than its WX series. They have bigger motors with higher torque and 4X greater acceleration than standard models, as well as an aluminum vertical arm that is 15-30% stiffer than on previous units. Three models are suited to presses up to 500 m.t. Payload capacities are 6.6 to 15.4 lb.

Speed is the key to two lines of robots from Star Automation, introduced in mid-2018. Aimed at packaging, IML, and other fast-cycle jobs, the ZXW-VI series comes in two models:

- ZXW-1000VI for presses of 150 to 350 m.t., with takeout time of 0.48 sec and full dry cycle of 2.6 sec;
- ZXW-1600VI for presses of 350 to 850 m.t., with 0.83-sec takeout time and 3.8-sec dry cycle.

Even faster is the first of a new series, the ZPX-1000, for presses of 150 to 350 m.t., with 0.35-sec takeout time and 2.4-sec full dry cycle. It boasts new, lighter arm profiles, carbon-fiber vertical arm, and more powerful servomotors than on the ZXW line.

Boosting performance: Wittmann's new Sonic series is said to be 60-70% faster than its WX series. Yushin's new MKA-200S for machines of 1500 tons and larger handles payloads of 66 to 110 lb while operating 10-17% faster than Yushin's earlier large robots.

In six-axis articulated robots, Kuka presented the KR Quantec 2 series, with higher speed and 10% smaller dimensions, fast deliveries, and reduced total cost of ownership, thanks to optimized maintenance, 50% fewer main components, and fewer spare parts. They come in rated payload capacities of 120 to 210 kg (264 to 462 lb) and max. reach from 2701 to 3100 mm. They are also billed as the world's first industrial robots to feature digital plug-in motion modes—software add-ons for these operating modes:

- Path Mode for highest precision;
- Dynamic Mode for highest speed, giving around 10% faster cycles;
- Performance Mode for standard operations (98% of applications).

LOWER-COST AUTOMATION

As noted in November's Keeping Up section, Wittmann Battenfeld added two new models to its Primus line of economical servo robots—larger Primus 48/48T models for presses up to 900 m.t., and a telescoping-arm Primus 16T at the smaller end.

Sepro announced plans to bring out a prototype of a more affordable line of five-axis servo linear robots, called Success Line X, by the third quarter of this year. These will be based on a thorough redesign of Sepro's three-axis Success Line, to which

Later this year, Sepro plans to bring out its more affordable Success Line X with servo wrist, designed to "make five-axis robots standard for injection molding."

will be added a two-axis servo wrist from Yaskawa Motoman. With Success Line X, Sepro aims to "make five-axis robots standard for injection molding," according to company officials. Cartesian robots will thereby be enabled to take over more jobs from six-axis robots, giving advantages in speed and lower cost.Sepro also plans to roll out a redesigned and affordable five-axis Strong Line X of large robots in 2021.

Igus has launched a program of "low-cost automation." Shown at K was the brand-new robolink RL-DC jointed-arm servo robot with four or five axes. This compact device was also shown at the Boy Machines booth, where it fit easily inside a Boy 35 E VV vertical press. Designed for simple pick-and-place applications, its price starts around 7000 Euros. Also available are drylin DLE-DR delta ("spider") robots for high-speed pick-and-place jobs. Powered by electric stepper motors, this three-axis model handles up to 5 kg (11 lb) and makes up to 30 picks/min. It can be assembled from a kit. Price with controls starts a little under 5000 €.

COBOTS PROLIFERATE

Collaborative robots (cobots) are a growing trend in plastics processing, and they were evident throughout the show. Although this report focuses on injection molding, cobots also played a role in blow molding at the show—such as a Universal Robots model housed within a machine molding jerrycans (see last month's report).

As reported in December's Starting Up section, Germany's Hahn Group has re-established Rethink Robotics as a new subsidiary and has upgraded the quality, durability and payload capacity of its Sawyer one-armed cobot in a new Sawyer Black edition. A heavier-duty model is planned.

Sepro's exhibit included two demonstrations of its new alliance with Universal Robots, a leading cobot supplier. And Boy Machines presented an encore demonstration from previous shows, in which a cobot served drinks in freshly molded mugs. This year's exhibit featured a Kuka seven-axis cobot serving coffee.

As reported in last month's review of K Show injection molding news, Nissei operated a cell that molded bases and cups of champagne flutes from clear PLA ►

Nissei molded PLA champagne flutes in two parts on two presses. Two top-entry robots (left) delivered the parts to a Kawasaki dual-arm DuAro SCARA-type cobot that assembled the flutes (right).

bioresin. The cell used two presses and two Yushin top-entry robots to demold parts and bring them to an assembly station. There, a dual-arm SCARA-type cobot from Kawasaki Robotics assembled the two parts and placed finished flutes on a conveyor. The Kawasaki duAro operates collaboratively (in the presence of humans) with the aid of a collision-detection feature and a safety function that slows its motion when a person enters its working space.

"Low-cost automation" is a new program from Igus that includes the four- or five-axis Robolink articulated robot.

Muller Technology Colorado Inc.—the new name of CBW Automation, which was recently acquired by Mold & Robotics Group of Switzerland (itself now renamed Muller Group)—discussed its extensive product-development work in cobots for injection molded packaging. Muller is working with Omron's six-axis articulated cobot equipped with an integrated camera and able to be moved from machine to machine. The first application will be lid packing in consort with a CBW stacker.

OTHER ROBOT NEWS

Additional news from Muller Technology Colorado is that the latest generation of its IML side-entry robot was redesigned to trim energy consumption by up to 40%. Muller also is bringing to the U.S. IML automation technology from its European operations. This equipment will be built in the U.S. for faster deliveries.

Meanwhile, Boy showed off its expanding portfolio of automation solutions with a version of its three-axis parts remover expanded to four axes with a wrist.

Campetella Robotic Center of Italy (represented here by Hunter Automation & Robotics) operated a dedicated system with three robots for production of home-compostable coffee capsules (or pods) with IML. A four-axis X-Series Mini-Modula side-entry robot inserted the labels and removed the finished capsules, placing them on a conveyor. A camera inspected the capsules. At the end of the conveyor, an X-Series SPIN1 SCARA robot picked up pairs of capsules and transferred them to another conveyor. Finally, an X-Series MC2-2H five-axis Cartesian top-entry model performed stacking and palletizing, using a new upstacker that can handle two to eight parts at a time. Total cycle time was 8 sec.

As reported in our September K preview, Engel showed a new "multidynamic" function for its viper Cartesian robots, which adjusts speed according to the payload; a new Engel pic A sprue picker; and new "compact safety cell." Engel also presented an impressively complex composite over-molding cell with two ovens and three integrated six-axis robots to preheat and load three different organosheet blanks.

Hekuma demonstrated its latest Hekutip automation cell for demolding, inspecting, cavity separation and packing pipette tips (see September Keeping Up).

Sepro, as noted above, is overhauling its popular Success line of Cartesian robots, with the results available for delivery in the second quarter. The new generation will have sleek styling and features like an extended strip stroke, which can potentially allow a robot of a given size to service a press of larger tonnage than before. Sepro also has returned to cam-follower bearings for linear motions of the new robots. Patented years ago by Sepro to handle heavy payloads and long strokes on large robots, they are now standard on all models. These bearings are said to provide more even weight distribution and smoother operation than linear bearings and to be also more reliable, durable and tolerant of dust and other contaminants.

Muller Technology Colorado (formerly CBW Automation) is working with Omron's cobots to develop a system that can pick and place IML packaging (top) and inspect it with an integral camera (bottom).

Also new is Sepro's Visual Production Dashboard that captures data from the robot and the whole cell to help improve ►

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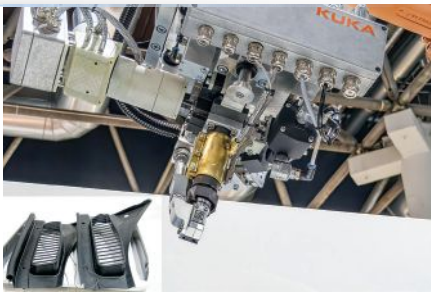
plant efficiency. Sepro's Visual robot control can aggregate the data produced by the whole cell—injection press and peripherals—with its own measurements to calculate the cell's OEE in real time.

As reported in November Keeping Up, Hahn's Waldorf Technik subsidiary demonstrated the latest version of its Vario TIP system for demolding and cavity sorting of syringe barrels. Waldorf also showed off Hahn's new EVE Suite of digital services, such as remote monitoring and maintenance support.

Meanwhile, Hahn's Wemo robot subsidiary displayed new WIPS 4.0 control software and a new handheld pendant with 10-in. touchscreen that takes gesture commands, as well as the new xPacker palletizing robot (also reported in November).



Kuka introduced a new extrusion head for its six-axis robots, which can deposit gaskets directly onto molded parts (inset, left).

Wittmann Battenfeld introduced a complete redesign with the WX138 robot for presses of 150 to 300 m.t. (26.4 lb payload). It has a fixed kick stroke to the front and replaces the model W828 with kick-axis forward design, as well as the W821 and W831 with moving kick axis. Other new features are the greatly increased rigidity of the vertical axis and concealing the drive unit inside the profiles of the main ("Z") and demolding ("X") axes, eliminating pinch points (see November Keeping Up for more details). It comes with the new R9-WLAN Teachbox pendant, whose cradle doubles as a charging station.

Kuka is testing a new, intuitive, icon-based programming method for its six-axis robots. Called Kuka.IconProg, it's designed as a simpler alternative to conventional KRL programming language. With IconProg, the user selects the building blocks of an operating program from a library of more than 600 functions and assembles them in a graphical sequence diagram.

In addition, Kuka recently acquired another company that brings simulation and augmented reality to planning equipment layout (collision detection and distance check) and offline robot programming. It's called Kuka.Sim Pro.

Also new from Kuka is an extrusion head that can be mounted on a robot to apply a thermoplastic gasket to a molded part (photo).

Staübli has a new tool changer for six-axis robots. It's a standard, modular unit that is configurable, rather than custom, enabling shorter lead times. Staübli says it's the only one on the market now with ISO level D, category 3 mechanical safety, sought by the automotive industry. The pneumatic system cannot unlock the tool when it's mounted on the robot—only when it's on the tool-changing stand.

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MATERIALS

PART 6

Polyethylene Fundamentals: Part 6 of 6

Don't assume you know everything there is to know about PE because it's been around so long. Here is yet another example of how the performance of PE is influenced by molecular weight and density.

By Mike Sepe

Before we leave the topic of polyethylene grade selection, it may be productive to look at one more practical example of how the performance of PE is influenced by the dual considerations of molecular weight and density. This case study involves a relatively large molded part that was being produced in a variety of colors in an HDPE with a melt-flow rate of 7.0 g/10 min and a density of 0.952 g/cm³. Periodically the supplier of these parts would receive complaints from the field about cracking. It was assumed that these cracks occurred due to relatively high mechanical stresses that were part of the application.

However, when this problem became significant enough to start tracing it back from the field through the manufacturing process, a review of parts in inventory showed that cracking was occurring spontaneously in parts that had never been in service. It was further determined that recently molded parts were free of the defect, but older parts did show evidence of cracking; and the older the parts were, the more extensive the cracks appeared to be.

This is not an uncommon problem in PE. The combination of stresses from poor design elements, such as sharp corners and rapid changes in wall thickness, coupled with the ability of the material to increase in crystallinity over time, produces a condition where the inherent strength of the material is exceeded and cracks begin to form. Over time, these cracks can grow to be significant. The problem is almost always related to the density of the material being too high.

When the various colors were examined, it was found that all colors were susceptible to this failure mode, with the exception of black. So, what was different about the black material? It turns out that black parts were molded from a mixture of reground colors that were then made black by the addition of a color concentrate. This concentrate was based on LLDPE. In actuality, all the colors were produced using concentrates based on LLDPE. But coloring

HDPE parts colored with masterbatches were cracking due to gradual increase in crystallinity after molding. Only parts colored black to hide mixed-color regrind used a high enough level of black LLDPE masterbatch to effectively lower the average density of the parts, reduce crystallinity, and avoid cracking. (Photo: Chroma Color)

natural material only required a letdown ratio of 2 lb of concentrate per 100 lb of natural. Getting a good black color when using a mixture of colors required a much higher concentrate loading.

Adding this concentrate at the level needed to achieve a satisfactory color was effectively reducing the density and therefore the crystallinity of the material, making it less susceptible to brittle failure. Although it is often the case that a reduction in density results in lower strength and stiffness, in this case a lower density did not compromise the performance of the parts because the nominal wall of the part was relatively thick. There was no noticeable difference in the load-bearing performance of the black parts compared with any other color.

This pointed to a solution for the other colors. A recommendation was made to reduce the density and, if possible, increase the average molecular weight of the material used to produce the parts. Often it is important to the processor to be able to remain with a ►

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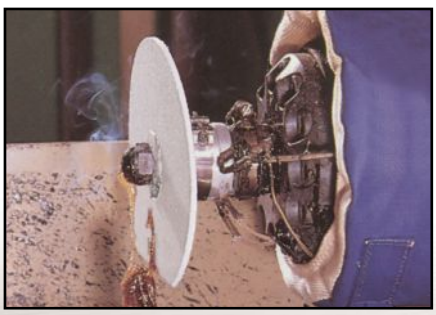

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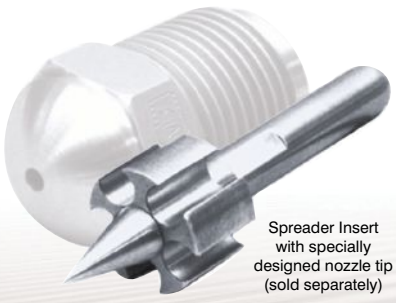

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given material supplier, so the product line for that supplier must be reviewed for viable options. For this particular product line, the next step down in density was to 0.946 g/cm³ and a grade with this density was available with a melt-flow rate (MFR) of 5.0 g/10 min.

This provided the opportunity to make two changes that both improve the toughness of the material. The lower MFR is associated with an increase in the average molecular weight of the polymer, and the lower density, provided a reduction in the crystallinity of the part. Given the relatively small change in MFR, it was anticipated that an improvement in performance would be attributable primarily to the reduction in density. As expected, the short-term mechanical properties of the part were not altered in any noticeable way.

In PE, exposure to higher temperatures can promote multiple processes that can lead to cracking.

The problem now became one of verifying that the change that was made was sufficient to solve the field problem. It was determined that at room temperature, spontaneous cracking of the parts molded in the higher-density material occurred in about 12 months. Exposure to elevated temperatures is often used to accelerate a failure and allow for a rapid determination of fitness for use.

In this case, parts molded in the higher-density material were placed in an oven set at 93 C (200 F). Cracks began to appear in these parts in a little less than 8 hr. It is tempting in situations like this to establish an equivalence between the elevated temperature and room temperature without establishing the mechanism for the acceleration. In PE, exposure to higher temperatures can promote multiple processes that can lead to cracking. One of these, and the one that is of interest here, is an acceleration in the rate at which additional crystallization occurs. However, other processes such as oxidation can also contribute to a loss in toughness. So, it is important to establish that the old material and the new material contain sufficient stabilization so that oxidation cannot occur.

Assuming that this is done, tests on the new material with the lower density and the higher molecular weight can be performed as a comparison. In this case, the new material did not show cracks until the aging time reached 130 hr, about 16 times longer than in the original higher-density material. This represents a single data point generated at a relatively high temperature. In order to establish a reasonable calculation for an anticipated lifetime for the new material, it is advisable to perform this comparison at one or two additional temperatures in order to determine whether this 16-fold improvement can be relied upon.

But even if the degree of improvement is somewhat more modest, the results of these tests indicate that lowering the density of the material by a relatively small amount will likely extend the life of the product to a very significant degree. In addition, the lower density and higher average molecular weight of the new material will provide for improved performance under the influence of the stresses associated with field use.

This is one more example of the importance of understanding the role of molecular weight and density in selecting a PE. Too often we refer to materials as commodities because of their relatively low cost. This gives the impression that we don't need to put much thought into the selection process. And after 80 years of using PE we perhaps assume that we know everything there is to know. But the experience of dealing with field failures suggests that we have a lot to learn. PT

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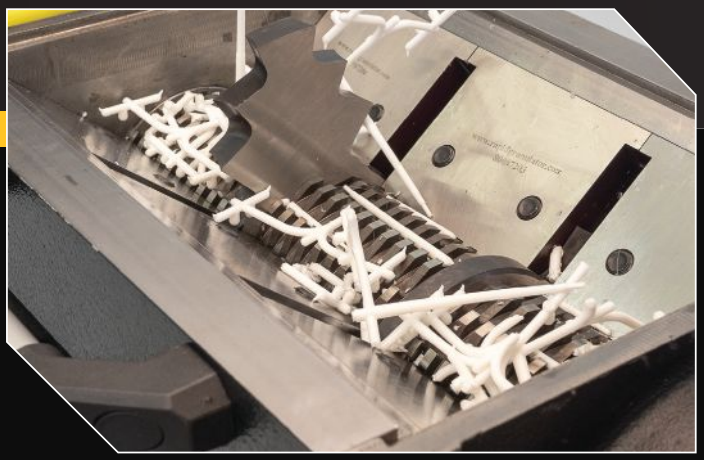

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INJECTION MOLDING

Don't Get Caught in the Flash-and-Shorts Chase

Injection molding's most common defects can have inverse correlation, where correcting one causes the other, leading to the "chase."

By Robert Gattshall

The technology available today for injection molding is very impressive, providing molders with tools to increase part complexity and improve the quality and accuracy of production. Yet even with these advances there are still two obstacles that molders have to deal with.

Throughout my career, I have had the opportunity to visit many different injection molding facilities spanning multiple industries, and the one thing they all share are their top scrap reasons—flash and short shots. These are by far the most common defects in injection molding. One reason for this is that in most cases they are direct opposites of one another.

Many of the actions we take to eliminate shorts can result in flash and vice versa. These actions can be made via changes to the process, mold, or combination of the two.

For example: Shorts can be caused by inadequate venting in the mold, and to help eliminate these shorts, we may need to increase the depth of existing vents or add more. However, it is possible that by doing so, the result could be excessive flash. Now that flash is present, we decide to resolve our new problem by compromising the process to increase material viscosity. This can be done by lowering the melt temperature, causing an injection-pressure increase. This increased pressure increases our Delta P—the difference between maximum pressure used vs. maximum pressure required—so that the pressure now exceeds the maximum available injection pressure of the machine, which results in—you guessed it—sporadic short shots due to being pressure limited. So we're back to where we started.

So, as you can imagine, there can be a fine line between flash and shorts, and that fact can shrink our process window significantly. Our goal as a processor is to find that middle ground far enough away from either side so that normal process variation doesn't result in either defect.

FLASH'S ROOT CAUSES

Flash can have many different causes, but two of the most common are excess cavity pressure and mold damage. Cavity pressure can cause flash when it exceeds the available clamp force. Once the clamp force is exceeded by the cavity pressure, the mold can physically open, allowing plastic to escape the cavity-forming steel. Excess cavity pressure can have many causes of its own, including a blocked gate preventing some of the cavities from being filled. Mold damage can also allow for plastic to escape the cavity-forming steel by preventing the parting line from sealing properly.

Attempting to "fix" short shots (left) can result in producing flash (right) and vice versa. A better approach is to start with an optimized process and seek the root cause of the initial problem—shorts or flash—and resolve that issue.

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COMING UP 'SHORT'

Shorts or short shots are under-filled parts that are typically missing features due to lack of plastic. Sinks and under-packed parts can sometimes be related to shorts or can be an indication ►

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that shorts are starting. Shorts can be caused by a number of reasons, and it is critical to identify the root cause before trying to address them. Common causes include improper venting that prevents gasses from escaping so that plastic can't flow into the cavity; or the nonreturn valve on the screw not closing properly and plastic flowing backwards as the machine injects. As I have stated in a previous column, understanding the *why* is critical to correcting the issue.

FINDING THE ROOT CAUSE, AVOIDING THE CHASE

Keep in mind that both shorts and flash are symptoms of a deeper problem. We must understand what is causing the symptom before trying to fix it. For example, increasing shot size when shorts suddenly appear can result in flash, if the root cause isn't understood before making the change. If the shorts are caused by debris stuck in the nonreturn valve, forcing it to remain open during injection, increasing your shot size may eliminate the shorts until the debris works free. Once the debris is freed from the nonreturn valve, and it is once again allowed to close properly, the extra shot size we added could cause the cavity pressure to exceed the clamping pressure and result in flashing the mold.

In my experience flash and shorts are among the main problems that can start the "*chase.*" That refers to making process changes on a machine multiple times in reaction to the current defect. Example: A short is discovered and the machine operator informs the process technician of the issue. This busy technician stops what he or she is working on to come over to the machine and increases the hold pressure without doing any sort of root-cause investigation. The technician looks at a shot to verify the shorts are gone and tells the operator the parts are good to pack.

Let me be clear here and say that process changes should be the last thing we do to correct an issue. If the machine was running good parts and suddenly is producing shorts, something changed in that process, and it must be identified to resolve the issue. That said, we all get busy and pressure can push us towards the path of least resistance in order to move on to the next problem. We should always troubleshoot an issue and identify the root cause before making modifications, but that doesn't always happen—it should, but it doesn't.

Back to our example: A little time goes by and the operator starts seeing flash on the parts—that's right, flash on the machine that was just producing shorts. It turns out that whatever was causing the shorts is sporadic and the additional hold pressure that was added is now causing the mold to flash. The operator gets a different technician, who notices that someone increased the hold pressure and now there is flash, so of course this technician lowers the hold pressure. No more flash, problem solved. What happens next? The sporadic issue that's causing the shorts hits again and they return, forcing the operator to seek help again to address the shorts. This chase can go on for hours or even longer, depending on the skill level of the process team, the size of the overall process window, and the actual root cause.

When I think about this type of chase, as a processor, it does feel like something is working against you. I've been there. I can recall several shifts spent chasing a process early in my career, not knowing any better and being responsible for 12 aging machines with poorly designed molds and just trying to move on to the next firefight. In these cases, we bring this on ourselves to some extent, but it can take you off your game, especially if you're trying to be in multiple places at the same time.

When it comes to troubleshooting flash and shorts, the first step is identifying which one is really the issue. Since they can be direct opposites of each other, it is key to know which defect is present at the optimal processing conditions. For example: Even though shorts are the issue we are currently seeing, flash could ultimately be what needs to be addressed. Flash could be preventing us from increasing our hold pressure to an optimal setting to compensate for normal process variation, which is resulting in short shots. So the issue we should be addressing is the flash at our optimal process setting and not the shorts that are currently present. The above example is important to remember during process development, as well. Just because you can make a few good-looking parts by reducing the hold pressure, that doesn't mean that the process is robust enough to accommodate normal process variation in production. If we can develop a process that can prevent normal process variation from causing defects, troubleshooting becomes much more simplified and helps those process technicians make better decisions.

Just because you can make a few good-looking parts by reducing the hold pressure, that doesn't mean that the process is robust enough to accommodate normal process variation in production.

Finding the optimal process between flash and shorts will always be an obstacle for molders. I would also venture to say that they will continue to be the top scrap reasons for most molders. But how you approach problem solving will determine whether you chase these defects or will solve them.

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

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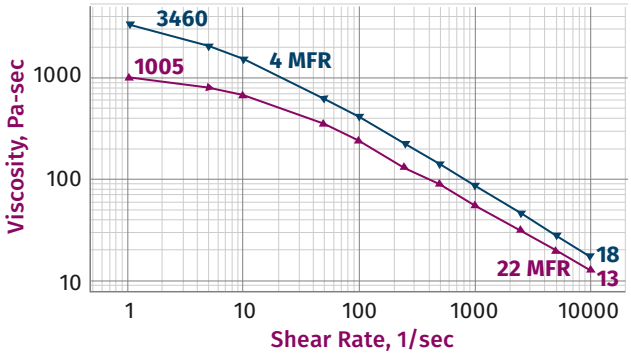
EXTRUSION

Try This Lower-Cost Purging Method

You might be able to reduce purging times and save money by scheduling processing jobs in the order of increasing material viscosity. But to get started, you'll need shear rate/viscosity curves for your polymers.

FIG 1 Viscosity vs. Shear Rate for 4-MFR and 22-MFR PP



The 22 MFR PP will not effectively purge the 4 MFR resin because although they melt at the same temperature, the viscosities are substantially different.

By Jim Frankland

Purging is a necessary task for extrusion processors that change polymers for different production runs. There are many approaches to purging, and some are better than others. For extrusion processors that run different materials, the biggest time and polymer savings may not be in some magical purging technique or compound, but in the production-planning process.

Ideally, to reduce purging time and cost, processing jobs should be run in the order of increasing viscosity based on their normal range of processing temperatures. Of course, that's not always practical, as production runs tend to be to be scheduled when orders are received or as requested. That said, when purging can be done this way it can provide an enormous reduction in waste by simply purging one polymer with another.

Its easier to purge a lower-viscosity polymer with a higher-viscosity polymer than vice versa.

Depending on the product requirements, a small amount of residual polymer from the previous processing run will not necessarily negatively affect the next run, meaning that *complete* purging is not always absolutely necessary. This is not obvious or published information, and some testing will be required to determine how much, if any, residual polymer can be tolerated in the next product. For example, simply changing color sequences can affect the acceptability of a small amount of residual polymer from the previous production run. However, it's seldom that any polymer contaminated with any purging compound can be used, so it's worth a look to find the acceptable level of cross-contamination.

It's easier to purge a lower-viscosity polymer with a higher-viscosity polymer than vice versa. When processing two grades of the same polymer, the melt flows need to be considered; and the one with the lower melt flow will purge the one with the higher melt flow better than vice versa.

As Fig. 1 shows, the 22-MFR PP will not effectively purge the 4-MFR PP because they melt at the same temperature and the viscosities are substantially different. Keep in mind that these are log/log plots and the difference in viscosity of the 4 and 22 MFR at a shear rate of 100 sec^{-1} is a ratio of almost 2:1.

In addition to following the practice of increasing viscosity for purging, the use of increasing melting point can also be deployed with crystalline polymers. With amorphous polymers this is difficult, as they soften at their glass-transition temperature, which is much lower than their processing temperature, and then simply get progressively softer as the temperature rises. Selective-temperature purging on that basis would require a whole series of shear-rate/viscosity curves well below the processing temperature, which are not generally available. As a result it's less complicated to work with just shear-rate/viscosity curves for all your polymers at their normal processing temperature when evaluating their purging effectiveness.

To make the most effective decisions in planning your sequence of jobs, having the shear-rate/viscosity curves is an absolute neces-

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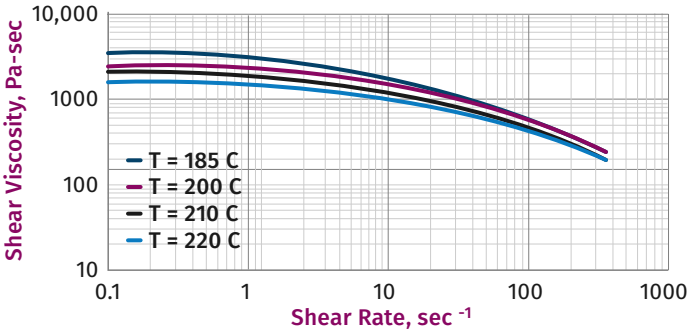
FIG 2

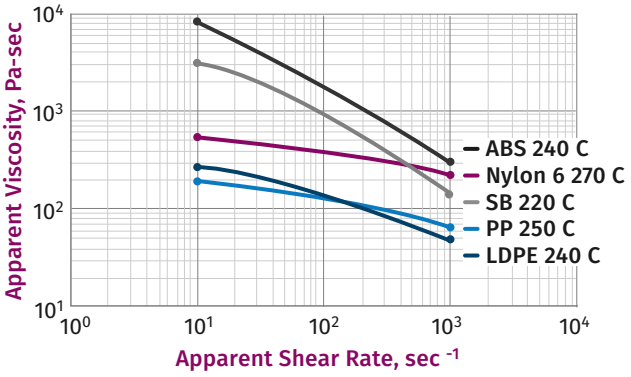
Impact of Temperature and Shear Rate on Viscosity



Most polymer viscosities are not affected nearly as much by temperature as by shear rate in their normal processing ranges. In a typical processing range of 100 sec^{-1} the viscosities of most polymers are very similar over the 35° C (63° F) temperature range.

FIG 3

The Shear-Thinning Effect



100 sec^{-1} is a good shear-rate range to consider for purging because it's typical of a medium to high extruder speed. So ABS or nylon 6 will be a good purge for SB.

sity. Just having melt-flow rates will only work with the same polymer (Fig. 1) as the melt-flow testing for different polymers is done at different test conditions and cannot be easily compared. Shear-rate/viscosity curves for each polymer are usually shown in their normal processing range, so by comparing the curves it's easy to pick the one that would have the highest viscosity.

Most polymer viscosities are not affected nearly as much by temperature as by shear rate in their normal processing ranges, so minor variations between the temperatures at which the shear-rate/viscosity curves were tested can generally be overlooked, as shown in Fig 2. In a typical processing range of 100 sec^{-1} the viscosities are very similar over the 35° C (63° F) temperature range.

I usually consider 100 sec^{-1} a good shear-rate range to consider for purging because it's typical of a medium to high extruder speed. Figure 3 shows that ABS or nylon 6 will be a good purge for SB. However, the viscosity curves for PP and LDPE cross over at about 100 sec^{-1} shear rate, so at lower speed you could possibly purge LDPE with PP, but the situation reverses at very high speeds. Through the whole range of shear rates for PP and LDPE, the viscosities actually do not vary much, making them generally poor choices to purge one another. All of these polymers process in a relatively narrow range of temperatures, so there is only a minor advantage to selecting the one with the highest melting point as the purging material. As you can see, without the viscosity curves it's often difficult to arrive at a clear judgment.

There are many "home-grown" procedures for purging—such as throwing in a cup of water to steam-clean the screw—but in general the higher the screw speed the more effective the shear forces are in cleaning the screw and tooling. However, in some cases the tooling can have "eddy" currents in less streamlined areas, so oscillation of the screw speed from low to high can be effective. Changes in output not only change the volume of flow but the viscosity. As you can see from the shear-rate/viscosity curves, the viscosity is much higher at very low shear rates and can be effective at purging.

Changes in output not only change the volume of flow but the viscosity.

This is often referred to as the "disco method," developed by DuPont. Oscillation of the barrel and tooling temperatures can be added to further improve this method. For example, temporary higher tooling temperatures can improve purging, as that has only a minor effect on the polymer temperature and viscosity except immediately adjacent to the walls. Naturally, care should be exercised not to raise the tooling temperatures too high so that burning or degradation occurs on the walls.

Regardless of the procedure used, development of a sequence of processing conditions to purge effectively between polymers can provide enormous savings in time, polymer and purging compound. But again, to be effective you need shear-rate/viscosity curves for your polymers before you can get started. They can generally be obtained from your polymer supplier, the internet or by sending small samples to a test lab. Then start evaluating the best sequential purging schedule by evaluating the time and scrap generated by each sequence. There is money to be made in the results. 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*.

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TOOLING

Save Time, Money: Use a Mold-Design Checklist

Here are 15 examples of common molding issues that occur during an initial mold trial. Many of them could be avoided or corrected with a proactive checklist.

By Jim Fattori

Injection molders quote or estimate a job based on six primary factors: part weight, material cost, machine size, cycle time, labor requirements and packaging. The material and packaging costs are relatively easy to obtain from suppliers, which makes them fixed values—not estimates. Thanks to solid-modeling software programs, part weight is also a fixed value, based on the model's volume and the density of the material.

That leaves three variables, or estimates made by the person quoting the job: cycle time, machine size and labor requirements. These three estimates typically determine whether you are going to make money or lose your shirt. More often than not, the mold design can control all three of these variables, because the estimator doesn't base his or her costs on having an issue with the mold. He, or she, bases them on the mold performing as it should—in the correct machine, at the anticipated cycle time, and with the required number of operators.

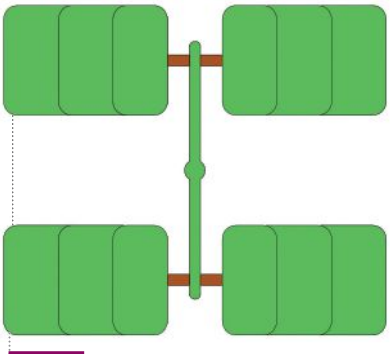

FIG 1 Difficult-to-balance cavities.

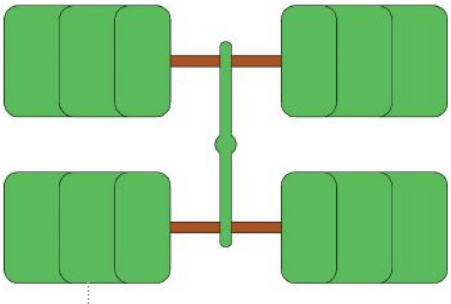

FIG 2 Easier-to-balance cavities (due to long runner branches).

Smart moldmakers use a mold-design checklist to help ensure they don't overlook anything. Most checklists that I have seen include details such as pry slots, insulator plates, steel types, safety straps, interlocks, etc. They all relate to the mold construction, but not the molding process.

The automotive and medical industries (as well as the military) insist on using all sorts of comprehensive checklists, with acronyms such as APQP (Advanced Product Quality Planning), PPAP (Production Part Approval Process), FMEA (Failure Mode and Effects Analysis), DOE (Design of Experiments), IQ/OQ/PQ (Installation Qualification/Operational Qualification/Process Qualification) and Mil Spec (Military Specification). Most of these checklists address the function of the part, or the repeatability of the mold and machine to make the part.

Very few checklists are geared toward preventing mold-design problems that arise at the initial mold sampling. I'm talking about problems that cause the cycle time to be extended, the machine size to be larger, the labor requirements to be increased—or even prevent the mold from running in full auto mode. They don't include any "what if" questions. What can be done if this or that happens during the initial mold trial? I call this a "Proactive Mold Design Checklist." Merriam-Webster aptly defines proactive as "acting in anticipation of future problems, needs, or changes."

In this column I'll give 15 examples of common molding issues that occur during an initial mold trial. Many of them are avoidable or correctable with a proactive checklist. Each example will list a question or questions that relate to the problem, which you might want to add to your checklist.

COMMON MOLDING ISSUES

1. A mold is built and it's time to sample it. The machine tonnage, tiebar spacing and shot size were all taken into account during the mold design phase. The processor starts to dial in the machine settings. The first thing he encounters is the 4-in.-tall part will not eject off the core because the machine only has 3½ in. of ejector stroke. Oops!
   - Do we have the intended molding machine's specification?
   - Is the machine's ejector stroke long enough?
   - If not, can outboard puller bars, or some other mechanical method be added?

2. The mold has an eight-drop hot-runner system with 12 heat zones. The processor has no idea what zone controls which component. He turns the controller on. The zones that come up to heat slowly are for the manifold. The zones that come up to heat quickly are for the cavities.
   - Is a wiring schematic needed for the molder?
   - If so, do the zone numbers correspond to the cavity numbers?

3. The mold has a stripper-plate ejection system. When the processor starts to determine the transfer position by making progressively larger short shots, the parts don't eject because the stripper plate is not pushing against any plastic yet.

Cycle time, machine size and labor requirements are the big three cost variables that can be controlled by the mold design.

   - Was the shot volume provided to the molder in cubic inches, or the shot weight in grams? The processor can do the math based on the barrel diameter and the volume, or can simply take an air shot and weigh it.

4. The cavities are out of balance. Some of them fill out way before the others, but the processor can't identify which cavities are the short ones.
   - Is the cavity identification engraved near the gate, and not at the end of fill?

5. The four inside cavities fill first and the four outboard cavities are short.
   - Is each runner branch feeding the parts long enough to be effective when attempting to balance the cavities after the initial trial? Do not attempt to balance a mold by modifying the gate sizes. Gate widths and depths should be identical to all cavities. Otherwise, you will get packing and warping issues. You will also get an extended cycle time due to a variation in gate-freeze time. Balance the cavities by changing individual runner diameters. Long runner branches make it easier to balance individual cavities (see Figs. 1 and 2).

6. A mold-filling analysis was performed prior to designing the mold, and the results said the part requires 100 tons of clamp pressure. The mold is sampled in a larger, 150-ton machine, but the processor still can't pack out the sink without getting flash.
   - Should the parting line be relieved for more clamp force around the cavity? ►

- Should the center support pillar(s) be pre-loaded?
- Are the clamp plates thick enough to counteract platen wear?
- Can the sprue, runner and gate sizes be increased if necessary to reduce the injection pressure?
- Should a flash trap be added around the perimeter of the runner?
- Can a second gate be added to the part if necessary?

7. The mold-filling analysis estimated the cycle time to be 30 sec. That is what the estimator used when quoting the job. The best cycle the processor could achieve in order to make a good part was 40 sec due to inadequate cooling in various areas.
   - Are all of the molding areas adequately cooled? This includes everything from the sprue bushing, to the end of fill.
   - Should any area of the part be cored out?
   - Should the core or any other mold component be made of beryllium copper, aluminum, or other thermally conductive material, especially for molds with short cycle times, thick wall sections, and places that are difficult to add a cooling channel?
   - Would conformal cooling be beneficial?
   - Would a post-molding cooling fixture be beneficial?

8. The part is sub-gated into either the ejection or the injection side of the mold. Upon mold opening, or upon ejection, the sub-gate breaks off the runner and stays in the mold, blocking the cavity on the next shot.
   - Is there sufficient land length on the ejector pin, or puller pin next to the gate, so that it can be shortened, to form a longer boss connected to the runner?
   - Can a stiffening rib or gusset be added in case there is an issue with the gate?
   - If the ejector pin, or puller pin next to the gate, ends up being too close or too far away, is there room to add another pin in a different location? The location of the ejector pin or gate puller frequently doesn't allow the runner to flex, or it allows it to flex too much. That is often why a sub-gate breaks off.

9. The parts have a fairly thin wall section and the material is unfilled nylon 66. The injection velocity is pretty fast, so the parts fill before the small gates freeze off. The parts have a lot of burn marks, but if the processor slows the injection speed, the cavities won't fill.
   - Should a perimeter vent be added?
   - Should a runner vent near the gate be added?
   - Can any rib, boss or other "dead zone" be vented? ►

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- Should a vent pin or porous metal insert be added?
- Can the land lengths of the vents be shortened if necessary?
- Can a flow leader be added if the part is difficult to fill?

10. When sufficient pack pressure is used to eliminate the sink marks, the part wants to stick in the cavity. When mold release is sprayed in the cavity, the sticking goes away for a few shots.
    - Is there sufficient draft on the outside of the part?
    - Can undercuts or a rough texture be added to the core?
    - Should a vent or air poppet be added to the cavity?

11. When sufficient pack pressure is used to eliminate the sink marks, the ejector pins try to push through and leave circular stress marks on the part.
    - Can more or larger ejector pins be added if there is a "pin-push" issue?
    - Has a draw polish been specified to help with release?
    - Is there sufficient draft on the inside of the part?
    - Should a lubricous plating or coating be added to the core?

12. The parts have deep, thin ribs. At first, the ejector pins push right through ribs. The parts eject, but the ribs break off and stay in the core. The processor's hands are badly bruised from trying to remove the ribs with a propane torch and a straightened out band clamp. After several attempts and a lot of frustration, the small ejector pins under the ribs simply buckle and break. In addition to the checklist questions above:
    - Should bosses be added to any ribs or deep impressions?
    - Should blade ejection be added to ribs for more ejection contact area?
    - Should a "floating" insert be added to release any ribs or deep impressions?

13. The mold has two opposing lifters, which form undercuts on the part. When the ejector plate advances forward, the part releases from one of the lifters, and sticks like glue to the other. Multiple ejector pulses still don't eject the part. It just goes back and forth for a ride.
    - Should a boss, rib or pointed ejector pin be added to keep the part centered during ejection?
    - Should a two-stage ejector system be added?
    - Can an air blast be added if there is an ejection issue?

14. The runner on a three-plate mold is a real problem. Sometimes it hangs up on the sucker pins. Sometimes it curls and won't fall out of the mold. Sometimes it hangs up on the extended sprue bushing due to nozzle-tip drool.
    - Does the runner clear the range bolts, springs, interlocks, or other obstructions?
    - Should the body of the sucker pins enter the runner about 0.010 in. to prevent "hang-ups?"
    - Should a thin stiffening rib be added to the runner to prevent it from curling?
    - Should an air- or spring-actuated poppet with a long throw be added to push the runner off the floating X-1 plate?

15. The job was quoted using one-half an operator—in other words, one operator being able to attend to two machines. Therefore, the mold must run fully automatic and the operator must have sufficient time to perform such operations as degate the runner, apply a part label, put the part in a polybag, neatly pack the parts in a box, and inspect the part quality. Trimming flash is never taken into account when quoting a job. All of this leads to a few more checklist questions.
    - Can an operator degate the part cleanly and without too much difficulty?
    - Can the gate be recessed into the part?
    - Will a sub-gate, cashew gate or split pin gate help reduce the operator requirements?
    - Will the parts scuff or become damaged if they are ejected onto a chute or conveyor?
    - Will a robot or picker be used to remove the part?
    - If so, can the mold open up enough for the robot to fit inside?
    - Is the machine's max. daylight sufficient for robotic extraction?

Here's a tip that the moldmaker, the molder, and the estimator should keep in mind: Molding machines have different hourly rates based on their clamp tonnage. The larger the machine, the higher the rate. In contrast, a molding machine operator has a fixed overhead rate, regardless of the machine size. If the press has an hourly rate less than the operator's burden rate, the primary concern should be the labor requirements. Conversely, if the molding machine has an hourly rate more than the operator's burden rate, the primary concern should be the overall cycle time.

There is an old saying in our industry: A moldmaker is only as good as his last mold. Molders understand that almost every mold is unique. They usually don't get upset when an unforeseen problem arises. If the moldmaker says, "We considered the possibility of that happening during the design phase and we have an action plan in mind," the molder is probably going to be impressed.

However, when a common mold problem occurs—one that is not unique and should have been foreseen and prevented—that is when the likelihood of a moldmaker getting another job starts to diminish. This is why the use of a thorough checklist can be financially invaluable. The checklist should be a "living" document, updated whenever an issue occurs. And they occur all the time. PT

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 in Pennsylvania. Contact *jim@injectionmoldconsulting.com*; *injectionmoldconsulting.com*.

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By Jim Callari
Editorial Director

Innovation, Customization & Sustainability:

How FlexFilms Focuses on U.S. Market

Global player in BOPET film has big plans for U.S. market with innovative products developed collaboratively with customers while paying heed to environmental concerns.

A worldwide producer of biaxially oriented packaging films has brought its culture of innovation and commitment to sustainability to the North American market. FlexFilms is the global film manufacturing arm of UFlex Ltd., India's largest multinational flexible packaging company. With its 2013 opening of a 180,000 ft² plant in Elizabethtown, Ky., the firm has state-of-the-art film manufacturing plants in the U.S., India, United Arab Emirates, Mexico, Egypt and Poland, with cumulative production capacity in excess of 337,000 metric tons (almost 743 million lb) per year, serving brand owners and other customers in roughly 140 countries.

The company's roots go back to 1994, when it started up its first BOPET line in India. Two years later, it installed a second BOPET line at the same location, along with a line for BOPP production. Through 2003, additional capacity was added for BOPP, metalizing, and cast BOPP. Its first foray out of India occurred in 2005, when it opened a plant in Dubai. In quick succession from 2009 through 2015, it set up plants in Mexico, Egypt, Poland and the U.S. Its strategy all along has been to build greenfield facilities as opposed to using acquisitions to enter new markets. Today, the firm generates about $1 billion in annual global sales.

FlexFilms' Vijay Yadav (l) and Anantshree Chaturvedi installed the largest BOPET line in the U.S. in 2013, measuring 8.7 meters wide.

FlexFilms' products can be found in a wide range of products, mostly food (human and pet).

FlexFilms has been selling in the U.S. since the mid-1990s, first out of New Jersey, then Charlotte and Houston. The pristine, air-conditioned production plant in Kentucky houses one production line for now: an 8.7-meter-wide line supplied by Lindauer Dornier of Germany, producing biaxially oriented PET (BOPET). The line is reportedly the largest of its kind "by far" in North America, says Vijay Yadav. He serves as FlexFilms' business head and has degrees in polymer engineering and advanced business management.

The Kentucky facility also has equipment for inline barrier metalizing and coating. The metalizer is 2.85 m wide, with a capacity of 5400 m.t./yr. Having metalizing and coating in-house along with film production gives FlexFilms more control over final product quality while also offering customers quick turnaround times.

The facility runs all day, every day, and has a nameplate capacity of 30,000 m.t./yr. Line speeds on average are 470-475 m/min, Yadav says. It produces films in thicknesses from 8 to 50 microns. The plant is situated on 32 acres of property, providing plenty of room for future expansion, says Anantshree Chaturvedi, FlexFilms' vice chairman and CEO. UFlex was founded in 1984 by Chaturvedi's father, who he said is considered "the father of the flexible packaging industry in India."

Globally, FlexFilms has production capacity not only for BOPET, but also for BOPP and cast PP, in addition to metalized and coated films, and a line of specialty films. Its primary markets are food (human and pet) and pharmaceutical packaging, and films for solar and construction applications. It has multiple lines it calls Alox that apply a thin and highly transparent coating of aluminum oxide on films that gives them extremely high moisture and gas barrier rivaling those of aluminium foils and metalized films. FlexFilms says it's the only truly high-barrier flexible packaging material available that is transparent and allows the packaged product to be clearly visible.

CUSTOMIZED SOLUTIONS

Having a global footprint might tempt a supplier of packaging materials to develop technology in one location and apply it across the board. FlexFilms doesn't operate that way. "We invest heavily in R&D, and make specialized products using specialized formulations," states Chaturvedi. "But you can't innovate in one part of the world and believe that the solution will apply globally. Our approach to working with customers is to be close—even local—and holistic. Every roll we produce is customized. Every roll has a unique identity. Our production operation is highly automated, but in a sense everything we make is 'hand made.' To be successful in this market you must have more than a transactional relationship with your customer. There must be interaction every step of the way. Moreover, we recognize that there is a certain premium and global recognition that goes with 'designed and developed in the U.S.'"

Chaturvedi says the FlexFilms' Kentucky line addresses a market where innovation had become stagnant. "In the U.S., before we came in, I don't think there had been a new BOPET line installed in 20 years. And we have room for four more lines. The U.S. market requires unique solutions. And there is a clear advantage in being closer to the customer, not only in terms of offering just-in-time delivery but in being able to work more closely on customized solutions."

"To be successful in this market you must have more than a transactional relationship with your customer. There must be interaction every step of the way."

Adds Yadav, "What we bring is a customized solution. We consider our customers to be our product-development partners. We strive to understand their products so that we fully understand what's required of our products, and we adapt our machinery and our processes accordingly." FlexFilms runs Davis-Standard extruders equipped with Coperion K-Tron gravimetric dosing units and a Nordson EDI die. Virtually every product it produces is a coextrusion.

It's as nimble as it is large: Product changeovers are executed in about 10 min, no small feat on a line of this magnitude. FlexFilms utilizes high-voltage pinning to secure the film to chill rolls. Film is then stretched in the machine direction on a series of rolls, then to heating ovens, where the film is clipped at both edges and stretched widthwise at a given temperature. The entire line is 430 ft long. ►

FlexFilms runs 24/7/365. It engineered its own production-monitoring system with support from Dornier and Siemens.

FlexFilms runs a range of coextrusions at thicknesses down to 8 microns.

It designed its process-control system—together with Siemens and Dornier—to provide complete line monitoring. Film samples are pulled regularly on each production run and are checked for gels and a full range of mechanical properties, including haze, tensile, elongation, coefficient of friction, and the like.

States Chaturvedi, "No two products that we engineer are likely to be the same—such is the level of customization we offer. With the support of our dedicated and agile workforce, we ensure an enviable speed-to-market reach, delivering innovation globally much ahead of the competition. Our unwavering focus on quality and sustainability, blended with our capabilities to service any order quantity and ensure Just-In-Time deliveries anywhere in the world, makes us truly unique."

DRIVEN BY INNOVATION, SUSTAINABILITY

Sustainability is a key driver of product development at FlexFilms. The company offers a line of "green" films containing up to 90% post-consumer reclaim, as well as halogen-free, ultra-clear barrier PET films with a proprietary coating that is billed as an alternative to PVDC. FlexFilms also manufactures a line of biobased PET films. New solutions include a patented, cold-forming BOPET film for pharmaceutical blister packaging; a series of easy-to-tear BOPET structures; a high-barrier, high-transparency BOPET film—another alternative to PVDC—as thin as 9.5 microns; isotropic metalized BOPET films for lids and seals; a new type of nylon-replacement film made with a newly developed proprietary technology. This film offers good thermoforming performance, high puncture resistance, and flexural fatigue strength suitable for many applications that formerly could be filled only with biaxially oriented nylon.

In its own production process, FlexFilms generates "very little waste," says Yadav. And this flexible packaging firm is also aware of its role in the ongoing environmental assault against plastics, packaging in particular. FlexFilms is taking a hands-on approach in helping to solve the problem.

In late September, as originally reported by *Plastics Technology* Executive Editor Matt Naitove, FlexFilms' parent company UFlex launched Project Plastic Fix, a four-pronged plan involving:

• Recycling of multilayer, multimaterial films with the aid of a compatibilizer into injection and blow molded products like garbage cans, highway dividers, and outdoor furniture. In 1995, the Davos Recycle Forum granted an award to UFlex for recycling printed, laminated film of metalized PET/LDPE/BOPP. In India, FlexFilms utilizes its own recycled films in the form of injection molded core plugs for its film rolls.

• Recycling post-consumer recycled (PCR) monolayer films into new films. FlexFilms has been doing this for 18 months in India and is now offering 90% PCR PET film and will soon launch a 100% PCR product.

• Using pyrolysis to convert plastics not easily recyclable by other means into fuel oil.

• Formulating plastic films to biodegrade into biomass, not "microplastic" particles. UFlex developed a patented "biodegradable enzyme," called Flexzyme that reportedly allows for 100% degradation by natural soil bacteria. Use life of products can be tuned to months or years before degradation begins. According to Chaturvedi, this is the only commercial technology that allows plastic products to be both fully recyclable and fully biodegradable.

Chaturvedi says UFlex uses all four of these technologies in India now, and plans to introduce them selectively at its facilities in Poland, Mexico, Egypt and U.S. For example, its Mexican BOPET film plant will install an Erema machine to reclaim PCR in the third quarter of 2020. And UFlex is willing to license these technologies to others.

Waste collection for these recycling initiatives, as reported by Naitove, will be done by individuals engaged directly by UFlex—"thus eliminating the middleman that typically would see the largest benefit from these transactions," according to Chaturvedi. "Importantly, Project Plastic Fix contributes to poverty alleviation, as the person responsible for collecting and depositing the waste receives the maximum return.

"I believe that while plastic cannot be removed from everyday living, it can be used and collected responsibly," says Chaturvedi. "We can have a solution to use the plastic that the world has already manufactured and ensure that it gets recycled and reused in the economy, in a variety of ways, without affecting the ecology." PT

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2019 AUXILIARY EQUIPMENT

Auxiliaries Stake Their Claim in the Circular Economy

The theme of sustainable plastics pervaded the exhibits at K 2019, even those of auxiliary equipment suppliers, where everything from dryers to blenders to hopper loaders was reimagined as part of a circular plastics process.

Motan's Metroflow gravimetric loader utilizes software to account for vibrations.

By Tony Deligio
Senior Editor

In auxiliary equipment at October's K 2019 show, the green-ward shift was manifested in new machinery designed for drying, conveying, blending and feeding recycled materials. Carl Litherland, chief marketing officer at Motan, said his company, like many others in Düsseldorf, was responding to customer and market interest. "We handle raw materials, whether they're virgin, regrind or recyclate," Litherland said, noting that for the latter materials, mechanical and physical properties are different from those of virgin pellets. "It's becoming more complicated; our product has to become more intelligent to recognize and deal with different materials."

MATERIAL HANDLING/CONVEYING

Motan introduced the Metro G/F/R (granulate, flake, regrind) at K, saying the unit can automatically load large quantities of granulate, dusty regrind and flakes, utilizing filters and large outlet flaps for smooth operation. Motan says dust is actively removed and conveyed to a central dust filter. The filter itself is made from PTFE-coated cloth, and a compressed-air accumulator integrated into the loader's lid has a direct connection to air outlet nozzles for filter cleaning.

A hinged lid, without vacuum and material hoses, allows the loaders to be easily cleaned during material changes. Metro G/F/R models use a large-diameter pneumatic butterfly valve for material discharge and to break up bridged material. A rotary paddle switch is installed below the valve to start the conveying cycle automatically when the material level drops below the sensor.

Motan's new Metroflow gravimetric loader weighs every load it processes with precision of <1% guaranteed, thanks to a digital load cell, using

control software to account for vibrations caused by the processing machine. Motan notes that since bulk densities can vary in recycled or reground materials, load weight accuracy becomes very important. Loaders come in 6-, 10-, and 30-liter capacities. The discharge flap's damper is spring loaded to prevent it from closing completely when not under vacuum. During a conveying cycle, any material left on the flap that could get trapped is sucked away. As vacuum increases, the flap presses against the spring and closes completely. Further, a counterweight for the discharge flap mounted on the outside of the loader indicates the loading cycle's status.

Instead of pneumatically operated discharge, the Metroflow uses a magnetic flap. Normally, after each conveying cycle, vacuum used for conveying is released and the material's weight would cause the discharge flap to open, but with the magnetic system, it remains closed. Only after the material in the loader has been weighed, is the holding magnet deactivated and the material is discharged.

Motan's Metro HBS three-phase loader handles throughputs from 661 to 3527 lb/hr and comes with a separate three-phase floor-standing lower station, with an alarm to indicate insufficient material. Automatic implosive filter cleaning is standard, and the units are available with two material inlets. A separate mixing valve isn't required, since the Metro HBS has an integral proportioning function for virgin and regrind material, allowing the ratio between the two streams to be adjusted. A single control can manage up to two loaders plus a blower.

Blending system supplier Plastrac introduced a patent-pending approach for continuous blending of color and other additives. ColorStream was conceived as a solution for a customer that wanted to eliminate employees climbing ladders or stairs to clean and change out additive hoppers located high above the plant floor and mounted on the sides of the main component loader. This new system separates additive metering from handling and feeding of the main resin component, locating it at floor level in a compact design for processors lacking space for a large floor-mounted blender along with the central loader/receiver for virgin material.

With ColorStream, cleaning and color changes occur at floor level, while all the system's components above floor level are self-cleaning. ColorStream comes in a compact cart, mounted on casters, and it can support up to four additive feeders arranged radially around a collecting funnel. This funnel discharges additives into a vertically mounted venturi that unloads downward into a transport hose. Unlike a conventional venturi, which requires high-pressure compressed air, ColorStream uses low-pressure air supplied by an electric regenerative blower on the cart. Plastrac says these blowers can operate continuously for more than five years, delivering clean air that whole time, since there are no contacting parts that require lubrication. The venturi and transport hose are small enough to deliver sufficient air velocity to keep pellets floating in the air stream even when using a small, energy-efficient blower.

At the upper end of the system, a baffle box mounts on the inlet flange of the processing machine. The box's top flange can support the central loader/receiver and buffer hopper, which supply virgin material. A cyclone-type receiver inside the baffle box separates the additives from the transport air. A metal screen between the cyclone and the exhaust duct keeps stray pellets from escaping with exhaust air. Pellets do not clog the screen because its much larger open area reduces air velocity below what would be required to lift the granules. Since surfaces are cleared by transport air or by the impingement of pellets, color changes don't require cleaning of the hose or baffle-box components.

Labotek (represented here by Romax) updated its conveying unit lineup, including systems for conveying flake that target recycled materials. The SVRF features a 100-liter hopper and 600-700 lb/hr throughput, with a special design to handle flake. In addition, the new SVR-P is designed to convey powder, targeting rotomolders and pipe manufacturers, among others. Featuring a redesigned flat filter on top with vibration and air to clean it, the unit's throughput ranges up to 4409 lb/hr.

Plastrac's ColorStream separates additive metering from handling and feeding of the main resin component, locating it at floor level.

Piovan displayed its Vakupulse technology, a dense-phase conveying technology it says is suited for conveying delicate raw materials at low speeds and flow rates over short distances. The company also debuted its Handlink+ manual coupling station. Piovan says the design makes it easy to connect pipes, even with only one hand. Gasket-free to prevent contamination, pellets come in contact only with stainless steel. The RFID tagging system ensures a match between material source and destinations. If there is a mismatch, the conveying system will not activate the loading cycle.

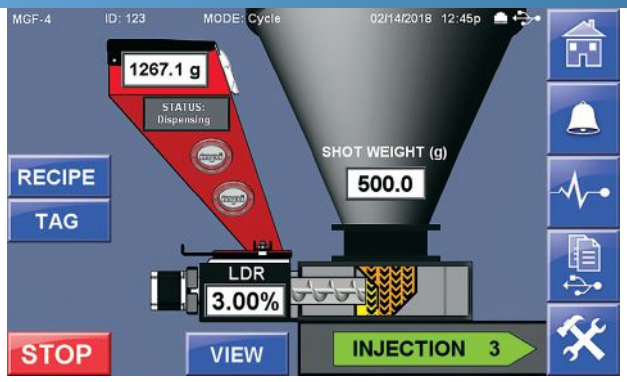
Piovan's FDM business, which targets extrusion, showcased the new GDS 5 gravimetric blender. Designed to mount up to five pellet stations, the company says the GDS 5 maintains compact dimensions and features a Siemens PLC controller.

Targeting medical production, Piovan also introduced a microdosing unit, capable of feeding machines with a single granule at a time. Targeting cleanrooms, Piovan displayed the Pureflo filterless receiver, which reportedly requires neither compressed air nor maintenance, and the emission-free DPA dryer.

Maguire extended its 100% Injection Coloring technology as an option for its MGF gravimetric feeders. The technology allows the feeders to meter in color during the recovery and injection phases of the screw. Maguire notes that in an injection molding cycle, roughly 75% of resin enters the screw during the recovery phase and 25% during injection. Since conventional feeders add color only during recovery, insufficient mixing can occur. Maguire's 100% Injection Coloring technology can eliminate typical answers to insufficiently mixed compounds, such as use of an upstream premixer or over-coloring.

Schenck rounded out its Proflex family with lower feed rates for smaller masterbatch applications. The C100 joins the C500, C3000 and C6000. Smallest of the group, it's a fit for smaller extruders. Up to five feeders can be grouped around an inlet of an extruder, and a quick-change hopper option allows for fast changeovers without disassembling the feed screw. The asymmetric design prevents bridging and plugging of sticky materials, and the integrated gearbox allows turndown ratios of up to 1:120. Schenck says a flexible wall allows constant and accurate filling of the feed screw.

Schenck also added to the Simplex line, which it launched at K 2016. The new Simplex FB 650, which joins the Simplex FB 1500, targets feeding of plastic flakes, cellulose, hemp, glass or carbon fibers, and other virgin or recycled materials for plastic film or compounding. Featuring a high-capacity, stainless-steel



Maguire's new technology allows feeders to meter in color during the recovery and injection phases of the screw.

feeder designed specifically for handling light and fluffy materials, the Simplex FG 650 uses a bottom-driven vertical agitator, as well as an auxiliary agitator, to process hard-to-feed materials, including chopped PP or PET film.

Movacolor of the Netherlands, distributed in North America by Hamilton Plastic Systems, Romax and others, introduced three new gravimetric feeding and blending systems at K 2019. The MCHigh Output 2500R high-capacity dosing unit is for low-bulk-density regrind such as bottle flake. The MCTwin system is designed for reprocessing colored regrind from injection molding sprues and rejects. And the MCContinuous Blender is aimed at wire and cable extrusion (see November 2019 Keeping Up).

Process Control introduced the WXOmega, developed in Germany and tailor-made for blending powder. Described as highly precise and energy efficient, the WXOmega powder batch dosing system can run up to six different powders. With dust-tight construction, each of the six powder hoppers has an integrated powder screw and bridge-breaking unit. The redesigned conical weigh hopper has a butterfly valve and special load cell for improved accuracy. In addition, the powder agitator in the mixing chamber helps homogenize material blends. Throughput ranges up to 551 lb/hr, and Process Control says all parts in contact with ingredients are of stainless steel. The touchscreen control comes with a 7- or 10-in. display.

Italy's Plastic Systems, which now has a U.S. headquarters in Atlanta, introduced a gravimetric blender for up to eight components, as well as new receivers for a central conveying system. These feature PLC controls that can be monitored or controlled remotely via smartphone or tablet. In addition, there was a new automatic manifold distribution system, with an optional weighing system that calculates resin usage, and the Easy Way 4.0 supervisory system, which collects and stores operating data for all injection machines and auxiliaries in a plant.

RESIN DRYING

Piovan debuted its GenesysNext drying system that the company says features "self-adaptive technology" optimized for recycled PET. Process air flow, dewpoint, residence time, temperature and more are automatically managed as hourly production and initial temperature and humidity of the plastic granulate vary. The original Genesys line launched in 2010.

Piovan says improvements have also been made to the AIPC (Automatic Injection Pressure Control) technology, which it claims ensures the lowest production cost for PET preforms. Piovan says the new control, which features predictive maintenance, connects the dryer with the injection molding machine. Measuring injection pressure via transducer every 5 millisec, the dryer can reportedly avoid overdrying PET. A new patented filtration system can absorb VOCs. The system signals an alert to change the filter when necessary.

The company also launched preform inspection products at K 2019. InspectAC allows molders to check a preform's acetaldehyde levels nondestructively. Instead of sending preforms to a lab, molders can check levels beside the press in 30 min. In addition, the InspectBE technology measures benzene, which can result from the PET recycling process. This unit measures benzene in parts per billion, inline, in 35 min. All of this can be connected via Piovan's winfactory platform.

Wittmann Battenfeld's new Aton H1000 battery dryer can handle a dry-air volume of 1000 m³/hr, for a drying throughput of 1102 lb to 1322 lb/hr. This marks the first extension of its Aton segmented-wheel dryers from beside-the-press to central drying duty. The company says the system can reach a -85 F dewpoint. Tied into the ►

company's Wittmann 4.0 platform, the Aton H1000 features a larger, 5.7-in touchscreen. The existing Aton line provides dry-air volumes from 30 to 120 m³/hr. Options for the Aton H1000 include dewpoint-controlled drying, with LED lights to indicate dryer status. Variable-frequency drive is also available.

ProTec's Somos RDF modular resin drying system, which consists of units with their own dry-air supply and controllers, also debuted at K. The individual operating units can be combined into an overall system with central visualization and control. The dryers are available with capacities from 50 to 400 liters and drying temperatures of 140 to 284 F; high-temperature models up to 356 F are available.

Wittmann Battenfeld's Aton H1000 battery dryer extends this segmented-wheel line from beside-the-press to central drying.

Maguire used K to rebrand its line of vacuum dryers with a new name—Ultra. These low-energy dryers are based on technology introduced by Maguire in 2013 under the name VBD (see September's K 2019 Preview).

Plastic Systems introduced a modular system of one to 10 honeycomb-rotor desiccant dryers, each with its own hopper. A single PLC control system allows for drying different resins simultaneously via independent, self-adaptive control for each hopper based on material level and drying-air temperature, dewpoint and airflow.

PROCESS HEATING & COOLING

HB-Therm of Switzerland debuted the Thermo-5 water temperature-control units (TCUs), featuring variable-speed radial pumps; temperature limits of 212, 284 and 320 F; heating capacity up to 32 kW; and cooling capacity up to 110 kW. The company noted the unit's compact size, with a height of 650 mm (not quite 25 in.), which allows it to be stored below most modern injection machines.

The TCU's Eco-pump variable-speed stainless-steel radial pumps work at a power of 2.2 kW and circulate a maximum of 220 l/min. In Eco mode, the unit can regulate the in/out temperature difference (ΔT), as well as flow rate or pump pressure, with all energy savings indicated and logged. Temperature control is said to be ±0.1° C with self-optimizing regulation. A tankless system with indirect cooling provides short heating and cooling times, since only the minimum necessary amount of heat-transfer fluid is used. The minimum circulation volume also requires less power. Mold-specific parameters can be saved and integrated into the molding machine's control.

The units feature automatic process monitoring, including ultrasonic flow measurement; hose rupture and leakage detection; a hydraulic circuit of corrosion-resistant materials; and a lifetime warranty for the heating unit. Heating elements have no direct contact with the fluid medium. Seal-less pumps further reduce maintenance. The closed system has no oxygen contact and utilizes active pressure regulation to protect molds. An optional OPC-UA interface "future-proofs" the units for Industry 4.0, according to HB-Therm. The TCUs can be remotely controlled, and through OPC-UA, they can share data with other machines, controllers, or QA and MES systems. An optional cleanroom package for Thermo-5 features fiber-free insulation, abrasion-resistant PUR rollers and a high-gloss finish.

HB Therm's Thermo-5 TCUs feature a lifetime warranty for the heating unit.

Mouldpro APS of Denmark introduced its digital flosense 4.0 cooling manifold at K. Distributed by Alba in the U.S., the flosense 4.0 can connect up to four manifolds, and its touchscreen can monitor up to 48 separate cooling circuits. As a replacement for analog manual flow regulators, Mouldpro says a digital flow manifold allows a higher flow capacity and temperature range, as well as data storage and export. Featuring an OPC-UA interface, the control's main screen shows all circuits, including data on flow and temperature, as well as pressure at the main inlet and outlet. By clicking on a specific circuit, users get more detailed information, including ΔT of that channel. A turbulent-flow indicator is included, and the system has an audit log to track all events. Data are stored in the internal memory and can be displayed graphically for each circuit, as well as exported for external use.

Single's new Easitemp 95 TCU features a compact, corrosion-resistant design and reportedly can handle continuous duty with low contamination sensitivity and consistent performance even under heavy loads. With 6 kW heating capacity for continuous duty up to 203 F, the Easitemp has 45 kW cooling capacity at 176 F inlet temperature and 59 F coolant temperature. The immersion pump is rated for 40 l/min and 3.8 bar, and reverse-polarity connectors provide a leak-stop mode and tool unloading with particle filter.

S.i.S.E. of France introduced color touchscreens on its oil and water TCUs. Also new is a range of pressurized-water TCUs (6 to 60 kW) for temperatures of 284 to 356 F and outputs from 60 to 200l/min. PT

2019 TOOLING & HOT RUNNERS

More Control, Faster Ordering for Molds, Hot Runners

Online monitoring of existing systems and configuration and ordering of new molds were featured at K 2019, as were numerous advances in valve-gate controls.

By Tony Deligio, *Senior Editor* & Matt Naitove, *Executive Editor*

During October's K 2019 show in Düsseldorf, several suppliers in the mold technology space rolled out online systems allowing users to spec out a tool package online and order it from the web. Among the items they can order: more and more sophisticated valve-gate system for precise control of melt flow. (For a full picture of hot-runner and tooling news at K, see the September show preview and Keeping Up sections in September to December. Also, go to ***ptonline.com*** for an expanded version of this article with more details as well as more coverage of mold components.)

HOT-RUNNER ADVANCES

Less downtime and more processing capability is the promise of Mold-Masters Melt-Cube EVO side-gating hot-runner system. At K, Mold-Masters offered attendees the chance to try out the new in-line design themselves. With this system, tips are secured by a single bolt, reportedly making mold service 85% faster. On a 64-cavity system, Mold-Masters says up to 5 hr of downtime could be saved. Offering simultaneous horizontal direct side gating for up to eight cavities, Mold-Masters says the Melt-Cube EVO is perfect for high-cavitation molds producing deep-draw medical parts.

Mold-Masters Melt Cube EVO features tips secured by a single bolt for faster service and installation.

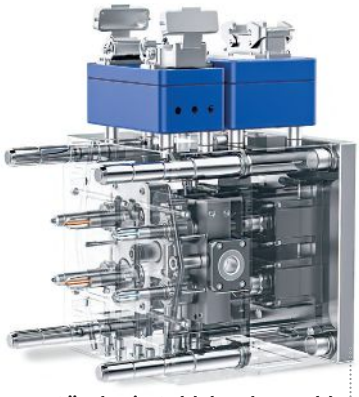
Melt-Cube EVO uses brazed heaters for a more consistent temperature profile. In testing, a delta T of only about 34° F was reportedly achieved. Use of brazed heaters also minimizes the number of control zones required. The gate-located tips are fixed to the cavity insert so that they're not affected by thermal expansion, helping maintain gate concentricity. Pitch range is 20 to 50 mm with a tip-to-tip distance of 70 mm. Maximum part weight is 10 g.

Mold-Masters also has a new pre-loaded nozzle spring design that seals the nozzle to the manifold for enhanced leakage protection, including on cold start-ups, as well as providing a wider

processing window of ± 100° C/180° F from the processing temperature. This MasterShield technology is now included as standard for Mold-Masters Sprint hot-runner systems for caps and closures.

Husky's newest hot-runner nozzle is aimed at challenging applications ranging from medical to automotive parts, such as family molds, two-shot molds, and large parts with sequential valve gating. The new Individual Servo Valve Gate (ISVG) offers servoelectric, closed-loop control of valve-stem speed, position, time, force, and stroke. The nozzle is powered by a new Altanium ISVG controller and a unique motor that's said to be highly reliable and durable—it will outlast any mold, Husky claims. The motor is installed in the mold plate, resulting in lower overall mold shut height. ISVG is available with up to eight drops and can use Ultra 350, to 750 VG, VX and Ultra Helix nozzles.

Günther emphasized its LSR cold-runner and 2K molding capabilities at K. It has renamed its cold-runner systems ColdFlow. New and possibly unique, according to Günther, is a single valve gate for LSR, called 5NEW. The ColdFlow portfolio also includes tight-pitch (12-mm) valve gates that open and close simultaneously with a pneumatic lifting plate. The Cold Flow hot-cold half for LSR/thermoplastic 2K overmolding in a single-face tool (pictured) is available in open-nozzle or valve-gate versions.



Günther's ColdFlow hot-cold half allows LSR/thermoplastic overmolding in a single tool.

For thermoplastic hot-runner molding, Günther has expanded its BlueFlow nozzles to include a larger model with 8-mm melt channel (up from a maximum of 6 mm previously). BlueFlow 8SHF/8DHF is an open single nozzle with heated adapter, available with tip (SHF) or straight outlet (DHF).

Runipsys, a French hot-runner supplier with an office in Windsor, Ont., showed its latest development, called Flow Driver. It's a programmable multi-speed valve-gate system that offers the option of "locks," or points during fill where the pin opens partially and then remains stationary to let the pressure equalize before opening further. This function is also useful for injection-compression molding, Runipsys says. The hydraulically operated system allows for up to two locks with a single speed setting, or up to two speeds with a single lock.

S.i.S.E., another French supplier (with an office in Atlanta), has a new valve-gate controller, the GC line (replacing the earlier IS series), designed specifically for sequential filling and for Industry 4.0. It can control filling time and pressure based on in-mold pressure and temperature sensors. The touchscreen unit has a startup function that synchronizes heat-up of the nozzles and manifold. It can save or send data to various users via the OPC-UA protocol.

Yudo Inc. of South Korea introduced a number of new products. One is the TINA MCH (Multi-Cavity High-Performance) nozzle for packaging, available in open or valve gate and in a range of sizes (5 to 63 mm² flow area). They have a stainless-steel body and allow for easy replacement of tip and heater in the press. New valve-gate products include electrically driven systems with a smaller motor installed directly behind the mold.

Heitec (represented in North America by Technoject Machinery) showed off a valve-gate system with five 35-mm-diam. nozzles arranged in a circle fed by a central melt-distribution channel. The gates were all driven simultaneously by a pneumatic or hydraulic plate.

The direction of development at Incoe is smaller sizes of nozzles and heaters with the same watt density or power. The goals: more compact components for smaller pitch distance, lower cost, and the same or better performance.

Mastip of New Zealand introduced next-generation Nexus pre-assembled and pre-wired systems (manifold with nozzles) delivered as a turnkey solution for quick and simple installation. They incorporate Mastip's FlowLoc screw-in, "leakproof" nozzles.

CONTROLLER ADVANCES

Mold-Masters' new TempMaster M3 controller platform offers simplified connection and Artificial Intelligence-powered processing. Mold-Masters says the new TC-Connect technology eliminates traditional thermocouple cables that account for 50% of all mold cables, allowing the system to cut cost, weight, and clutter from the molding cell. With TC-Connect, a new eBox attaches to the mold via a single data-communication cable. Similar in size to an Ethernet cable, the communication cable hooks from the back of the M3 controller to the eBox. Hot-runner wiring remains unchanged, and Mold-Masters says this technology is compatible with new and older hot runners.

Building on its proprietary APS (Adaptive Process System) algorithm, Mold-Masters says it has added artificial intelligence (AI). Mold-Masters says APS-AI automatically recognizes the behavioral characteristics of individual heaters and configures the controls to optimize each profile. This allows setpoints to be reached faster during startup, while avoiding overshoot or undershoot.

The TempMaster M3 controller platform will have four configurations—three traditional tower cabinets and one XS compact desktop cabinet. The controller utilizes a high-capacity 4z-15A modular control card, which reduces the number of cards required by up to 50%. Overall, Mold-Masters says the cabinets are 53% more compact than competitive designs, and they can be configured in four-zone increments with capacities of 24, 48, 96, and 192 zones, respectively. All controllers feature a high-resolution touchscreen display, measuring either 8, 12 or 17 in., depending on zone configuration.

Mold-Masters says transitioning from an M2 or M2+ control should be seamless as the new TempMaster interface was first introduced with TM-M2+, along with the original interface. The newest TempMaster will include advanced control capabilities carried over from its predecessors, including soft start, leak detection, continuous ground-fault detection, and rapid automatic tool diagnostics. An update to the tool diagnostics function allows it to assess high-cavitation systems in as little as 15 min.

DIGITALIZING MANUFACTURING, ORDERING

Husky discussed its Next Generation Operating Model (NGOM), which involves a "digitalized end-to-end manufacturing system" for its own products to bring enhanced speed and flexibility. An example that's still in development is online configuration of aftermarket PET preform tooling systems for lightweighting of existing products while retaining the same cavitation. (At present this is performed internally by Husky.) The company claims that NGOM so far has reduced preform tooling lead times from eight weeks to four weeks, with plans to reach two weeks later on.

Meusburger unveiled a new online tool to configure and customize a complete mold base, including hot-runner manifold, with just a few clicks. From selecting new plates to the number of cavities to the material being run (including the presence of glass fiber), the program allows a full system to be configured to customer specifications. A 3D model of the mold is created and users can enter the nozzle information from the intended injection molding machine, as well as water lines, before placing a finished mold in the online "cart." In addition to the hot runner, all required components and matching accessories can be ordered directly from Meusburger.

Mold-Masters' new TempMaster M3 Controller features single-cable connection and AI-powered processing.

MOLD MONITORING

Among several new developments from Progressive Components is its Asset Supply Tracking System, an addition to the company's mold-monitoring offerings, CVe and CVe Live. Called ProFileCV, the new product is more universal—not just for tracking molds, but also other capital assets such as machinery, auxiliaries, and even office equipment like copiers. It's customizable and similar in design to CVe Live. The system creates Asset Tags with unique QR codes for location tracking via GPS and asset inventory. All assets can be added to a secure, cloud-based database, stored by class and type, along with critical data for each asset. An online "Filing Cabinet" stores related documents such as manuals and warranties for any asset. The system can generate preventive-maintenance (PM) tasks and other work orders. In addition, this is designed as a cradle-to-grave system that tracks assets from the mold-design stage to the build stage, qualification, production launch, ongoing usage and maintenance, and finally to storage, retirement and destruction.

Meanwhile, there are several enhancements to Progressive's mold monitors. For CVe v3 there's new Maintenance On Demand, a built-in function that ensures that regular in-press mold maintenance is properly recorded—a step often overlooked in molding plants, Progressive says. Entries are time and date stamped, and multiple maintenance entries can be logged for multiple actions.

And CVe Live, the real-time mold monitor, is now available in multiple languages and has a new function to calculate and display OEE (overall equipment efficiency) by mold and press on the main dashboard. Also new is a QR code on the mold tag that pushes GPS location to the CVe Live database.

Haidlmair has created a new company, called Digital Moulds, to sell its Mould Monitoring system, which was introduced at K 2016. This small mold-mounted device transmits data (via GSM or WLAN) on numbers of mold cycles, cycle time, injection parameters (such as fill rate and pressure), production time, maintenance, and availability. Digital Moulds is developing Mould Lifecycle Management, cloud-based software that collects all mold documents, drawings, etc. in a database where it can be accessed by everyone involved in a project. In addition, the OEM can keep track of the mold's build progress at the moldmaker and its use in production.

S.i.S.E. unveiled its Smart Mold Box, to be launched early in 2020, which monitors a customizable set of injection parameters. This standalone, heavy-duty, mold-mounted device allows real-time monitoring of production and keeps track of the tool throughout its life cycle, both in operation and in storage. It can provide real-time display of process data on a connected PC or can transfer data to the cloud or an MES system.

In the area of QC, Husky's ShotScope NX now has integrated the PreMon preform monitoring system from IntraVis; it provides inline detection of color defects, black specks, and other issues that can come with increasing use of recycled materials.

New proximity switches from Hasco allow precise position monitoring, and unlike mechanical switches, they operate in contact-free mode and are wear free. The switches can detect electrically conductive workpieces when they sense an electromagnetic alternating field. The heat-resistant switches can manage high-temperature applications and have a stainless-steel housing that can be flush-mounted. Shock and vibration-resistant, the switches' wiring has short-circuit and reverse-polarity protection.

Meusburger presented new cavity-pressure sensors featuring

direct or indirect measurement. The sensors are compatible with all common piezoelectric pressure sensors, and since they require little space for installation, allow greater freedom in mold design.

MOLDS & TOOLING

In other tooling news, Canon Virginia showed its Multi Mold System, which shuttles two complete molds into and out of a press. At K 2019, Canon partnered with injection machine manufacturer Toyo Machinery & Metal Co. Ltd., molding two halves of a drain pipe that were then overmolded together into a complete hollow tube. In one tool, the four cavities formed half the drain. After molding, those halves were picked up by an end-of-arm-tool, rotated 180º, reinserted into the second mold and overmolded together.

The molds were made by Canon Mold Co. Ltd. in Japan. Including robot time and assembly, the process had a cycle of 120 sec. Running nylon 66, the process turned the normally idle cooling time into productive time. Outside the press, the mold halves were held together during cooling via magnets. Water lines remained connected the whole time in this design, differing from others using expensive quick-disconnects. Canon says molders with part-cooling times 20 sec and above can achieve significant productivity gains with the Multi Mold System; those with cooling times above 45 sec may double their production from a single press.

In preforms for carbonated soft drinks, Husky says major brands have conducted successful consumer trials with a new 26-22 style of bottle cap weighing 1.65 g, which Husky thinks will eventually replace the current 18-81 cap weighing 1.95 to 2.4 g. The new cap also means a shorter, lighter neck finish weighing 2.4 g, down from 3.8 g currently.

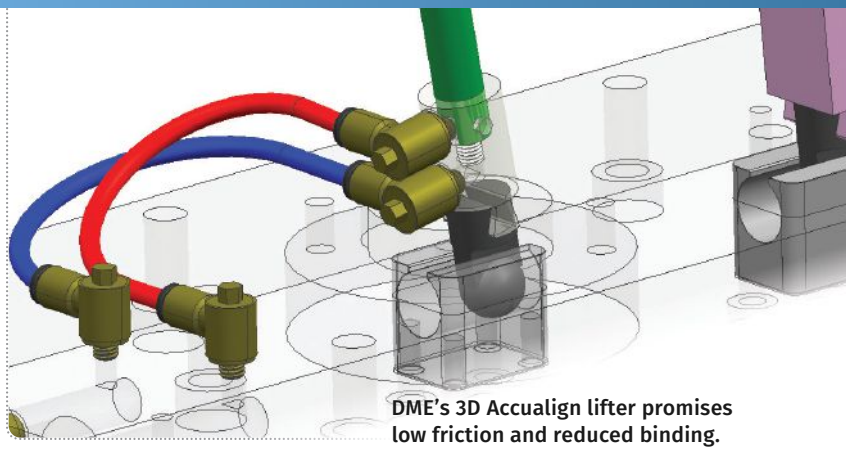
Husky also noted that a new European anti-litter law that takes effect July 2024 requires single-use containers of 3 L or less to have closures that are tethered to the bottle. Husky has worked with ►

Husky has worked with packaging producers to develop tethered caps with a hinge that "clicks" so it stays open.

major packaging producers like Aptar and Betapack to develop a portfolio of compliant closures, including ones with a hinge that "clicks" so it stays open and won't flap in the drinker's face.

More details were available on Husky's new NexPET system—mold, machine, and auxiliaries—for mid-volume producers of multiple different preforms. A typical customer would run three to five molds at up to 150-200 million units each annually. NexPET involves a new mold design (24, 32, or 48 cavities) with simplified design and fewer parts for faster changes. For example, standardized cavity plates allow economical conversion to new products. The mold, which accommodates up to a 38-mm thread, is just now commercially available (some are already running in Europe). The machine (approx. 225 tons) specially tailored for this system will become available this year with a choice of three injection-unit sizes.

In mold components, a new lifter for internal and external undercuts from DME uses a novel 3D ball self-alignment system, whereby a patented articulating long-life carbide ball operates within an alignment channel. The 3D Accualign Lifter is said to compensate for any misalignment opposite the release angle, ensuring low friction and reduced binding. The system enables molding of plastic parts with complex geometries, while reducing maintenance costs and downtime and increasing part quality. In addition, the 3D Accualign Lifter can incorporate DME's TruCool conformal-cooling technology to facilitate cooling in hard-to-reach areas.



DME's 3D Accualign lifter promises low friction and reduced binding.

The new DME QR Code insert allows QR codes to be added to the product during molding without making it a permanent part of the mold. The QR code, however, is permanent and can't be removed or wear off. The code can be used to provide customers more information about a product, options for reorder, documentation, and optional accessories, among other things.

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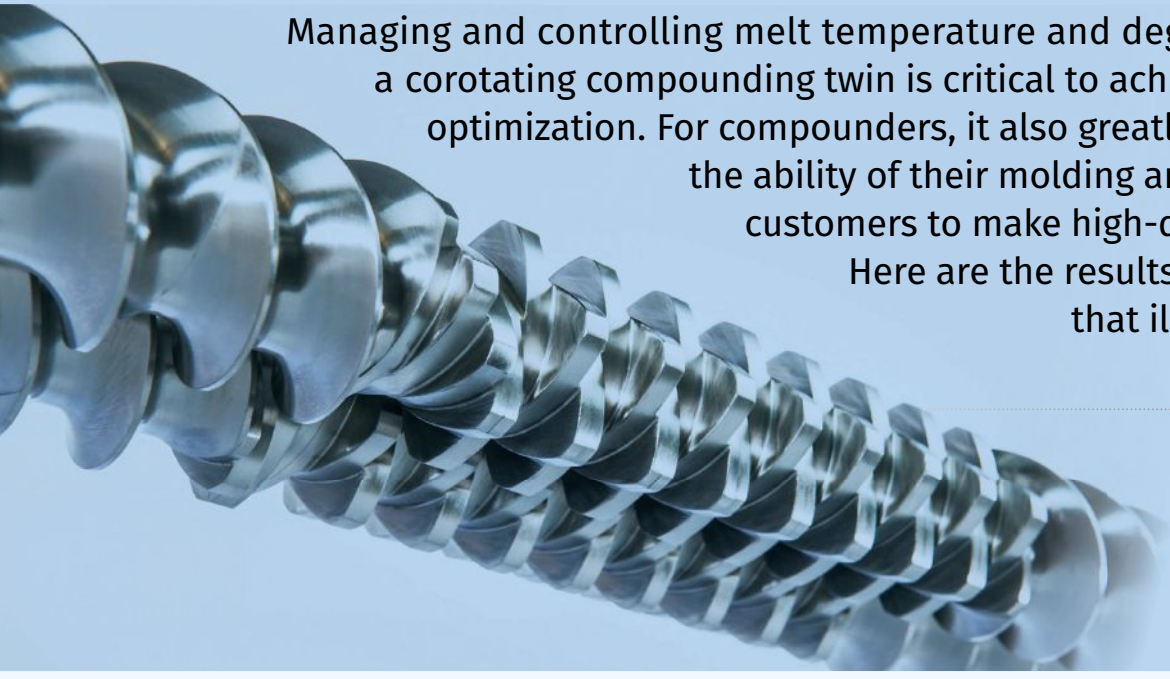
Why It's Crucial to Manage Melt-Temperature in a Twin-Screw Compounding Extruder



Managing and controlling melt temperature and degradation in a corotating compounding twin is critical to achieve process optimization. For compounders, it also greatly influences the ability of their molding and extrusion customers to make high-quality parts. Here are the results of research that illustrate this.

FIG 1
Twin-screws are powerful energy-input devices, with energy primarily derived from the motor.

By Charlie Martin & Brian Haight,
Leistritz Extrusion

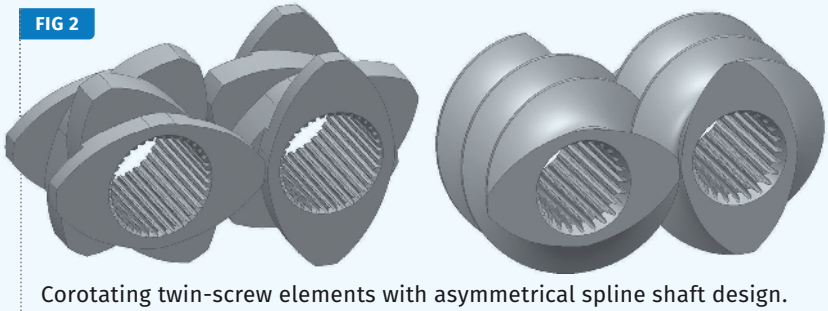
The corotating, intermeshing twin-screw extruder (TSE) is the compounding industry's most prevalent device for continuous mixing of polymers with additives and fillers (Fig. 1). Exotic formulations that utilize atypical active ingredients are also processed on this type of machine. Materials exposed to high shear and temperatures will degrade. Almost every product benefits by strategically managing how shear (and energy) is imparted to the materials being processed and is measured by the resulting melt temperature.

Various factors must be considered to manage and control the melt temperature. In this article, emphasis will be given to OD/ID ratio, the melting zone in the screws, and front-end design.

TWIN-SCREW EXTRUDER THEORY & DESIGN BASICS

TSEs utilize segmented screws that are assembled on high-torque splined shafts (Fig. 2). Barrels are also modular and utilize liquid cooling. The motor inputs energy into the process via rotating screws. Feeders meter materials into the TSE process section, and the screws' rpm is independent and set to optimize processing efficiencies. Segmented screws and barrels, in combination with the controlled pumping and wiping characteristics of the corotating screws, allow screw/barrel geometries to be matched to the process tasks. Solids conveying and melting occurs in the first part of the process section. Next come screw elements for mixing and devolatilization. Discharge elements then build and stabilize pressure to a die or front-end device.

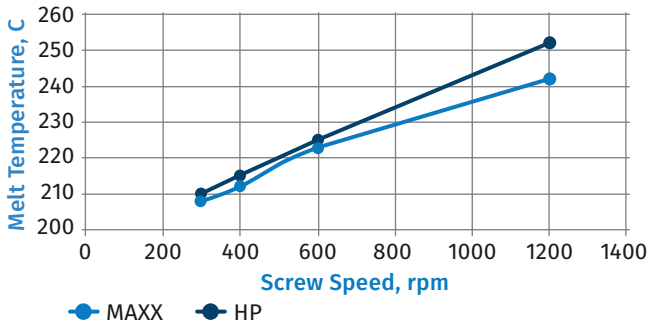
FIG 2



Corotating twin-screw elements with asymmetrical spline shaft design.

The free volume in the process section is related to the OD/ID ratio, which is defined by dividing the outside diameter (OD) by the inside diameter (ID) of each screw. Deeper screw flights result in more free volume and a lower average shear rate, but with less torque, since there will be a smaller screw-shaft diameter.

FIG 3 Melt-Temperature Comparison (HP vs. MAXX)



Results of tests where LDPE powder feedstock with 12 MFI was processed on a ZSE-27 HP (27 mm diam. screws, 1.5/1 OD/ID ratio) and a ZSE-27 MAXX (28.3 mm, 1.66/1 OD/ID). In each instance, the rate-limiting factor was the volumetric feed capacity. Melt temperatures were lower for the 1.66/1 OD/ID ratio (even at higher throughput rates) due to a lower specific-energy input (kWh) into each kg being processed and the gentler mixing effect associated with deep-flighted 1.66/1 OD/ID screw geometry.

Asymmetrical splined shaft designs offer optimum power-transmission efficiency so that a smaller shaft diameter can transmit higher torque than otherwise. This is accomplished by isolating the tangential force vector transmitted from the shafts to the screws by the motor. The combination of higher torque, lower average shear, and larger OD/ID ratio has proven beneficial for many processes.

In Leistritz nomenclature, the HP series has a 1.55/1 OD/ID ratio and uses a symmetrical splined shaft design, and the MAXX series uses a 1.66/1 OD/ID ratio with an asymmetrical splined shaft. Increasing the OD/ID ratio increases the free volume by approximately 20%, along with a higher torque rating.

WHAT EXPERIMENTS REVEALED

Experimental data was generated comparing 1.5/1 OD/ID and 1.66/1 model TSEs (Fig. 3). Process sections were interchangeable and mated to the same gearbox. Initial tests were performed with a neat resin with a 40:1 L/D process section and 40-hp motor:

LDPE powder feedstock with a 12 MFI was processed on a ZSE-27 HP (27 mm diam screws, 1.5/1 OD/ID ratio) and a ZSE-27 MAXX (28.3 mm screws, 1.66/1 OD/ID). In each instance, the rate-limiting factor was the volumetric feed capacity. The 1.66/1 OD/ID ratio made it possible to feed more material to the feed throat before encountering feed limitation. The increase in achievable feed rate was approximately 20% and comparable to the increased free volume associated with the higher OD/ID ratio. At elevated screw rpm (greater than 800), the percentage increase was not as pronounced, as the higher screw-tip velocity seemingly had a "propeller" effect that somewhat inhibited feeding.

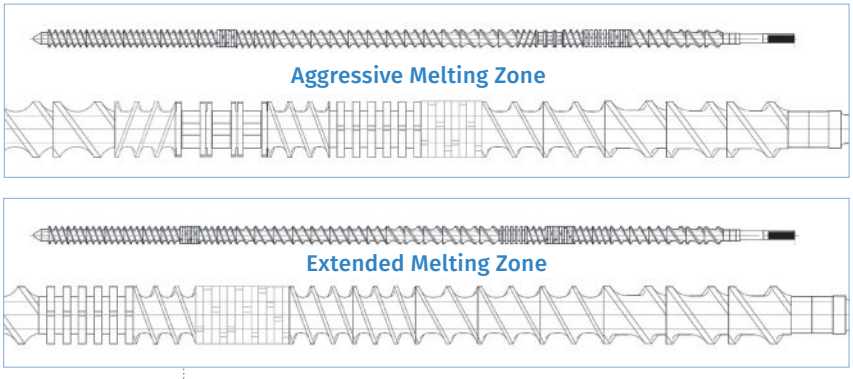
The corresponding melt temperatures were lower for the 1.66/1 OD/ID ratio (even at the higher throughput rates) due to a lower specific-energy input (kWh) into each kg being processed and the gentler mixing effect associated with deep-flighted 1.66/1 OD/ID screw geometry.

A series of additional experiments were performed on the ZSE-27 MAXX (1.66 OD/ID) to compare the resulting melt temperature for different melting-zone screw configurations with a 2 MFI PP pellet resin. An "aggressive" melting zone with melting completed by barrel position 3 (12 L/D) was compared with an "extended" melting zone (Fig. 4), where melting was completed by barrel position 4 (16 L/D). A single kneading-block set was used after melting in an attempt to isolate and compare the different melting-zone configurations and the resulting melt temperature. A low-pressure discharge die was used to minimize the effects of pressure on melt temperature. Both flush and immersion melt-temperature probes were utilized in the experiments. Tests were performed with various rates and screw rpm.

The aggressive melting-zone design utilizes neutral/wide disk kneading-block elements and a reverse element to achieve full melting of the polymer by barrel zone 3. The goal of the aggressive melt zone might be to specify a shorter L/D, or to free up space in latter parts of the process for additional unit operations, i.e. injection, mixing or devolatiliation.

In comparison, the extended screw design utilizes narrow disk kneading-block elements with less intensive shear-stress input into the polymer, which results in more gradual melting of the polymer.

FIG 4 Aggressive and Extended Screw Designs Used in the Study



Experimental data was collected on a ZSE 27 MAXX twin-screw extruder. (28.3 mm screws, 1.66/1 OD/ID ratio). A 2 MFI PE pellet resin was processed, the temperature profile was optimized, and various screw speeds were tested. In each instance, the melt temperature with the aggressive design was much higher than with the extended melt-zone design.

QUESTIONS ABOUT COMPOUNDING?

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Visit the Twin-Screw Compounding Zone.

The goal of the extended melt zone is to reduce the melt temperature and shear-stress exposure for the materials being processed. After melting, a single kneading-block section was integrated into the screw design to minimize temperature rise inherent in mixing.

The temperature profile was optimized and various screw rpms were tested. The data in the accompanying melt-temperature graphs was obtained with a handheld immersion probe.

In each instance, the melt temperature with the aggressive design was much higher (10° to 30° C) than with the extended melting-zone design (Fig. 5). It is worth noting that the immersion probe measured significantly higher temperatures (sometimes 20° to more than 40° C) than the flush melt probe. It is evident that when a melt probe is not fully immersed into the polymer melt, the melt-temperature reading is influenced by the metal adapter setpoint—lower than actual, and not accurate.

The attainable rates were also maximized for both designs by targeting 85% operating torque and increasing the rate until that threshold occurred. The extended melting-zone design resulted in both higher throughput rates than the aggressive screw design and lower melt temperatures. Comparing the two melting zones (aggressive and extended) showed that the aggressive melting zone caused a significant temperature rise and lower attainable throughput rates than with the extended melting zone. Higher temperatures inherent with the aggressive screw design also resulted in significant degradation, as indicated by smoke and discoloration at elevated screw rpm.

OTHER FACTORS THAT IMPACT MELT TEMPERATURE

The screw design in the melting zone directly impacts the melt temperature, and is significant. Temperature setpoints in this zone will also contribute to the the melt temperature. Perhaps counter-intuitively, higher setpoints generally result in a lower melt temperature. Accordingly, in this study a reverse temperature profile (higher temperature setting in the first part of the process) was selected to lessen the melt-temperature rise associated with the melting zone. An optimized melt zone is a good start.

In addition to melting, it is apparent that the screw must also be designed to melt and mix without excessive shear inducement. The use of wide kneading blocks and reverse elements for mixing will result in more energy being imparted to the process and further raise the melt temperature, and must be considered when designing the screw.

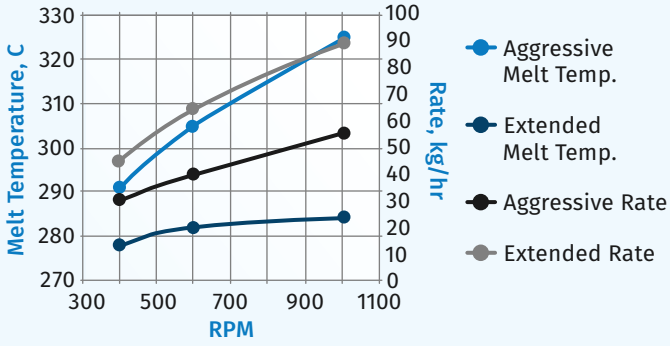
Often overlooked, pressure generation at the discharge of the TSE also adds to the melt temperature. The more restrictive the front end, the higher the pressure and corresponding melt temperature. The temperature rise associated with the front-end design can be estimated as follows:

Δ T (C) = Δ P (bar) ÷ 2

Δ T = Change in temperature (C)

Δ P = Change in pressure (1 bar = 14.503 psi)

FIG 5 **Melt Temperature and Maximum Rates vs. RPM**



Rates were maximized for both designs by targeting 85% operating torque and increasing the rate until that threshold occurred. The extended melting-zone design resulted in both higher rates than the aggressive screw design and lower melt temperatures. Comparing the two melting zones (aggressive and extended), the aggressive zone caused a significant temperature rise and lower attainable rates than with the extended melting zone. The higher temperatures inherent with the aggressive screw design also resulted in significant degradation, as indicated by smoke and discoloration at elevated screw rpm.

For example, if a TSE is processing 500 kg/hr and the die pressure is 40 bar (580 psi), then the associated melt-temperature rise can be 20° C (ΔT = 40 ÷ 2).

This formula is meant to be insightful, if not necessarily accurate, as screw rpm, the geometry of the discharge screw elements, temperature setpoints, and formulation viscosity are all factors in the resulting melt temperature. The point is that the front-end design must be considered when managing melt temperature in a corotating twin-screw extruder.

Corotating TSEs process wide-ranging polymer compounds for a myriad of products. Screw design, front-end configuration, temperature settings and operating conditions all impact what the formulation "experiences" in the process section and directly influence the properties of the final part. Managing melt temperature and minimizing degradation are key to making high-quality parts and must be considered to achieve optimization of any polymer process. PT

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PT Keeping Up With Technology

PRODUCT FOCUS Injection Molding

INJECTION MOLDING

High-Speed Electric Presses Get a Further Speed Boost

KraussMaffei's Netstal Elion high-speed presses for closures now boast even faster dry cycles. New control software is said to boost clamp movements by up to 0.2 sec across the entire model range from 80 to 420 metric tons. Netstal Elion machines can have all-electric drive in small to medium-size models up to 280 m.t. (including all the Elion Med medical versions). Servohydraulic injection is optional from 120 to 280 m.t. and standard on larger models.

KraussMaffei attributes the high speed of Elion machines largely to their unique clamp design, with a horizontal servo motor driving the centrally positioned, five-point dual-toggle lever. The speed boost is achieved on machines with the aXos controller, starting with v 8.2.0. New software provides adaptive optimization of the acceleration and deceleration ramps on the clamp so that maximum speed is reached faster and can be maintained longer before deceleration is applied, without compromising mold protection, KM says. What's more, the new software adjusts the speed ramps according to the mold weight, estimated on the basis of the mold-height setting.

As an example of the practical effect of these modifications, KM says an Elion 4200 (420 m.t.) with a 96-cavity mold producing Type 29/25 HDPE caps weighing 1.23 g each now achieves a cycle time of 2.6 sec vs. 2.77 sec previously. That results in output of 132,920 caps/hr, up from 124,750, a 6.5% increase.

INJECTION MOLDING

Pressure Transducer Accurate at Low Pressures & High Temperatures

Nominal Controls Inc. says its TrueMelt pressure transducers avoid the thermal-zero-shift errors that afflict standard melt-pressure transducers in processes like low-pressure molding or extrusion. The company says the TrueMelt sensor can measure low pressures at operating temperatures up to 600 C/1112 F.

Thermal zero shift or drift refers to the false pressure output of a sensor due to temperature increase. Nominal Controls said a typical drift value for a melt-pressure sensor can be more than 50 psi per 100°F. In applications such as thermoplastic composites that can be produced at pressures below 500 psi, zero drift can cause a pressure reading error of 10% or more, with potentially significantly impacts on product quality and consistency. TrueMelt transducers reportedly have a rated zero-shift error of less than 5 psi/100°F. Nominal Controls says its TrueMelt pressure transducers are the only thermally compensated pressure sensors with mV/V signal output.

INJECTION MOLDING

Work Stations Promote Lean Operations

The Pioneer IWS line of industrial workflow stations from Molders Choice is said to be a versatile and durable system to promote lean manufacturing principles. The units are constructed from 14-gauge steel that can support hundreds of pounds of tools and equipment. A single hook can hold up to 60 lb, and unlike composite pegboards, the welded design keeps hooks and shelving securely in place.

The units are customizable to satisfy different plant layouts and job requirements, including mold setup carts, operator workstations, mobile toolboxes, maintenance carts, quality-control carts and more. Two-sided stations are available for placement between two molding machines, and the workstations can be outfitted with casters for mobility.

Accessories include hooks, shelves, braces, headers, containers, paper-towel/cleaning-cloth dispensers, and rollers for labels. The accessories are interchangeable and available in wall-mount versions. Built from standard components, the workstations are easy to customize and configure. Basic mold setup carts start at $925.

INJECTION MOLDING

Largest Wittmann Robot Yet Handles 100 kg

The biggest Cartesian robot yet built by Wittmann Battenfeld is molding waste bins at Belli in Bellignat, France. The model W873XL was chosen because of its demolding ("X") stroke of 3 meters (3.28 ft) and ability to heft parts weighing up to 100 kg (220 lb). With that large demolding stroke, says Belli general manager Eric Chanal, "We don't have to work with only partial mold openings." He also notes that replacing the six-axis articulated robot previously used for this application frees up much more floor space for palletizing. And the Wittmann robot uses grippers that handle large parts with less extraction time. "Last, but not least, we are really fond of the Wittmann TeachBox console, because of its usability, making faultless robot programming so easy."

The customized design of this robot was adapted by Wittmann Battenfeld from its standard W873 model. Belli is so happy with this unit that it plans to order an even bigger robot.

INJECTION MOLDING

Check Ring Resists Corrosive Flame-Retardant Additives

At the recent K 2019 show in Germany, Zeiger Industries exhibited a new nonreturn check-ring valve assembly with a solid tungsten carbide ring, designed to resist the corrosive effects of halogen-free flame retardants (HFFR) used in plastics resins today. The rear seat of the check-ring valve is a steel with 20% chrome matrix, while the tip is coated with 1 mm of tungsten carbide. According to Stan Glover, director of technical sales, the new check-ring assembly showed no corrosion after 680 hr in molding tests, while standard powder-metallurgy (PM) stainless steel showed damage after 8 hr.

EXTRUSION

Control System for Wire, Cable

Maguire's new extrusion control system for wire and cable reportedly provides accurate control of grams-per-meter yield, improves product integrity, and reduces operating costs.

The Maguire + Syncro extrusion control system can be deployed in extrusion or coextrusion operations and in new or retrofit installations. Using data from a digital post-extrusion encoder and tachometer, the system adjusts extruder screw rpm and capstan speed to ensure tight coating tolerances and end-product consistency. In coextrusion, ratio control provides accurate dimensions for multiple sheathing layers or identifying stripes.

There are three basic components in the Maguire + Syncro system: the Maguire WXB Weigh Extrusion Blender (photo), which incorporates a gain-in-weight weigh bin and a loss-in-weight mix chamber; the Maguire 4088 controller, which controls loading, blending, and metering of raw material to the extrusion process; and the Syncro controller, which uses the consumption data from the 4088 controller and the downstream encoders to adjust line speed and haul-off. Modes of extrusion control available with the Maguire + Syncro system include g/m (or oz/ft) of extruded product and kg/hr or lb/hr.

Because color is a key factor in wire and cable for branding and coding, Maguire also supplies the MGF gravimetric feeder, which precisely measures the amount of additive that is fed directly into the extruder throat. Maguire also supplies raw-material vacuum loaders ranging from a compact "mini-central" loader to plant-wide systems.

MIXING

Triple-Shaft Mixer Can Pivot

The Ross VMC-1000 VersaMix is a 1000-gal Triple-Shaft Mixer available on a pivoting single-post hydraulic lift. The new design allows the machine to be raised from a vessel, rotated 90° and lowered into another vessel. This allows for convenient discharge of finished product in the first vessel while a new batch is being made in the second. By reducing overall processing time and minimizing downtime, the pivoting VersaMix reportedly saves time and money while simplifying mixing, discharging and cleaning. The VersaMix is available in working capacities from 1 qt to 2000 gal.

DRYING

New Dryers Boast Improved Energy Management

At K 2019, Koch-Technik launched the Ekon line of dry-air dryers, said to combine the best aspects of its CKT and EKO dryers. Available in eight sizes, the new line reportedly improves on the EKO series heat-exchanger design, recovering heat and reducing energy consumption by 20-30%. These dryers apply the company's ÖKO patented energy-management technology, which adapts the drying process to save energy and protect the materials. Koch-Technik says that combining dewpoint control with frequency regulation of the blower can yield energy savings of up to 50%.

Modular Ekon dryers range in capacity from 20 to 600 liters (5 to 160 gal) with throughputs from 110 to 2000 m^3/hr. They have a 10.4-in. touchscreen and can be connected to a corporate network via Ethernet to control drying centrally using Koch's visualization software. The Ekon line applies the OPC-UA open interface for Industry 4.0 compatibility.

MATERIALS

Full Range of High-Performance Cable Compounds

Increasing demands on power and telecommunications infrastructure led international polymer compounder Hexpol TPE (U.S. office in Sandusky, Ohio) to develop a new range of compounds for cable sheathing. Said to meet the highest levels of durability, performance and human safety, the Dryflex Cable range includes grades based on different polymer chemistries, including EVA, TPE and TPV. This reportedly brings one of the widest ranges of properties and customization possibilities to the market and gives cable manufacturers the flexibility to select the best solution for their application.

The Dryflex Cable range includes Low Smoke Halogen Free (LSHF) or Low Smoke Zero Halogen (LSZH) flame-retardant compounds. The compounds are RoHS, SVHC and REACH compliant and halogen-free according to IEC 60754 Part 1/2.

These compounds require no post-vulcanization. They are fully recyclable and any production waste can be reprocessed. These compounds reportedly offer excellent thermomechanical properties, making them suitable for both telecommunication and electric cables. Typical applications include low voltage, data, insulation, jacketing and bedding.

MATERIALS

Polyphenylsulfone with Improved Flow

A new polyphenylsulfone (PPSU) addition to the Ultrason P resin family from BASF reportedly offers improved flow in injection molding while maintaining excellent mechanical properties. Low-viscosity Ultrason P 2010 makes it possible to mold larger, complex-shaped components such as food dishes and heat-resistant containers with sophisticated, thin-wall geometries for catering and aircraft applications. In hotels, restaurants and canteens, containers and pans made of the material can be used to prepare food as well as to transport meals and keep them warm.

Now available globally in transparent and opaque, Ultrason P 2010 boasts a combination of the outstanding notched impact strength and stability of the already available Ultrason P 3010 along with high chemical resistance, good steam sterilization at 273 F/134 C and inherent fire resistance. The material's Charpy notched impact is tenfold higher than other amorphous high-temperature materials. Even the combination of aggressive cleaning agents and disinfectants, water and extreme heat does not affect Ultrason P 2010. Furthermore, the transparent product is approved for food contact in the EU and the U.S. Other uses could include seat and lighting cladding, air vents and overhead luggage compartments.

MATERIALS

Full Range of Compounds for 5G Antenna Cables

Teknor Apex is ready for the coming era of 5G telecommunications with a comprehensive suite of PVC and polyolefin compounds to meet carriers' needs for control/fiber-optic cable. The company has developed Apex PVC, Flexalloy PVC elastomer, and Halguard halogen-free low-smoke compounds for every component in the complex antenna cables required for the new infrastructure. Compounds are available for these 5G antenna cable applications:

- Buffers for high-speed data fibers at the core of the cable;
- Jackets for the multi-fiber core;
- Jackets for the bundles of 600V control cable surrounding the core;
- Sheathing for the entire construction.

These compounds include variations that meet different specifications from each wireless carrier, including specialty formulations for oil resistance, UV resistance, low- and high-temperature environments, and wet- and dry-rated insulations. There's also a stress-crack-resistant compound for jacketing over corrugated metal armor.

PS Prices Rise While Others Sink

Parity with global prices, higher feedstock costs, and ample supplies are among the drivers.

By Lilli Manolis Sherman
Senior Editor

Prices of PE and PP were expected to bottom out in January, when domestic polyolefin prices were largely in parity with global prices. Crude-oil prices moved higher in the first week of January amid escalating tensions in the Mideast, which helped feed international market sentiment that PE and PP prices had reached a bottom.

Driven solely by benzene prices, PS tabs were expected to move up. Lower feedstock costs for PVC and oversupply of PET were driving a downward trajectory for prices of those resins.

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

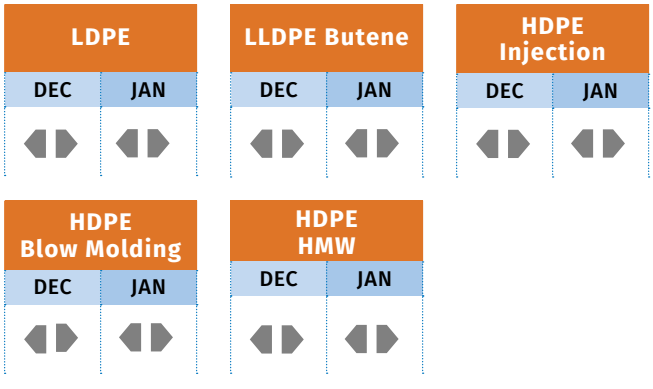
PE PRICES FLAT

Polyethylene prices in December were flat, although there were negotiated discounts of as much as 3¢, according to Mike Burns, RTi's v.p. of PE markets, and *PCW*'s senior editor, David Barry. They estimated that PE prices in 2019 dropped 3-6¢/lb. Meanwhile, suppliers issued increases of 4-5¢/lb for January.

The Plastic Exchange's Greenberg ventured that a price increase for January could be viable: "Demand is typically strong in January and prices usually start higher, much in contrast to a generally dismal December with its seasonal supply dump. Spot PE prices lifted a penny across the board as the New Year rang in, just as bullish market forces became more prevalent."

While both Burns and Barry thought PE prices were bottoming out, they saw last month as flat, with suppliers aiming to implement their increases more aggressively in February and March.

Polyethylene Price Trends



Market Prices Effective Mid-January 2020

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	92-94
LLDPE BUTENE, FILM	75-77
NYMEX 'FINANCIAL' FUTURES	28
JANUARY	29
HDPE, G-P INJECTION	97-99
HDPE, BLOW MOLDING	90-92
NYMEX 'FINANCIAL' FUTURES	29
JUNE	29
HDPE, HMW FILM	104-106
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	58-60
NYMEX 'FINANCIAL' FUTURES	38
JANUARY	38
IMPACT COPOLYMER	60-62
POLYSTYRENE (railcar)	
G-P CRYSTAL	105-107
HIPS	109-111
PVC RESIN (railcar)	
G-P HOMOPOLYMER	70-81
PIPE GRADE	78-80
PET (truckload)	
U.S. BOTTLE GRADE	45-47

These sources also noted that while the PE market was still oversupplied, suppliers' year-end inventory management had contributed to a somewhat more balanced market going into 2020. Burns noted that export constraints due to the January Chinese New Year may keep inventories ample in the first quarter.

PP PRICES BOTTOMED OUT?

Polypropylene prices dropped in December by 2¢/lb, in step with propylene monomer, on top of a further non-monomer-related reduction of 3.5¢/lb, according to Scott Newell, RTi's v.p. of PP markets. He noted that between June and year-end 2019, there were 7¢ of non-monomer-related PP price decreases, adding that the spread between PP and monomer had shrunk by 7¢/lb. According to both Newell and *PCW*'s Barry, most of this reduction took place in November-December, which saw significantly discounted spot deals on prime resin.

Barry and Greenberg said PP spot prices dropped 12-15¢/lb through last year. Said Newell, "When all the numbers are in for 2019, it will show that demand wasn't so bad because these deals were so good. But I think that activity will 'steal away' from first-quarter demand." These sources noted that export sales during that same time frame were also very good, which speaks to the fact that there was oversupply, or "distressed sales," as Newell puts it. While these sources speculated that PP prices might have bottomed out, they conceded that demand was still weak, and suppliers still had 37-38 days of resin inventory on hand.

Polypropylene Price Trends

Homopolymer	
DEC	JAN
↓ 5.5¢/lb	↓

Copolymer	
DEC	JAN
↓ 5.5¢/lb	↓

Greenberg reported that the PP spot market began to ramp back up just as the calendar turned to 2020. "There were some well-priced railcars that hung over from December and were snatched up by buyers; other processors required truckloads for quick shipment as their inventories dwindled into the year-end. Considering the uncertainty in the Middle East and new highs in crude-oil prices, which could trickle into resin, some processors have started to rebuild their inventories, citing low-cost opportunity vs. potential upside risk."

PS PRICES FLAT TO HIGHER

Polystyrene prices were flat in December after a 3¢ drop in November, but suppliers came out with a 3¢/lb price increase for Jan. 1. The move was precipitated by a 22¢/gal increase in benzene contract prices, which equated to a 2¢/lb increase on PS production costs, according to *PCW*'s Barry and Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets.

Noted Chesshier, "This is their opportunity to try to increase their margins," noting that butadiene contract prices also rose 5¢/lb, giving suppliers some momentum. However, she noted that the rising price of benzene, which represents 75-80% of styrene monomer production cost, has had no real effect in pulling up prices of the monomer, which stood at a low contract level of 41¢/lb, with spot prices at 37¢. According to Barry, the implied styrene monomer cost, based on a 30/70 ratio of spot ethylene/benzene, was 29.1¢/lb, up 3¢/lb over a four-week period. Barry also reported that the average December 2019 spot price of GPPS was 68¢/lb railcar delivered, down 9.3¢/lb from December 2018, and average spot HIPS was 72¢/lb, down 10.7¢/lb.

Polystyrene Price Trends

GPPS	
DEC	JAN
↔	↑ 2-3¢/lb

HIPS	
DEC	JAN
↔	↑ 2-3¢/lb

Meanwhile, Chesshier noted the uncertainties caused by the major plastic price indexes CDI and IHS Markit making significant downward "non-market adjustments" to their listed prices for PS and styrene monomer, respectively. ("Non-market adjustments" are corrections to index prices when there is a disparity vs. actual market conditions.) CDI dropped its GPPS listing by 38¢/lb and HIPS by 40¢; IHS posted a 15% lower price for monomer at 13.31¢/lb. Chesshier said of the PS adjustment, "This is one of the largest non-market adjustments in 10 years. When you tell the market that posted index prices are off by that much, it causes a lack of confidence." She saw this move as making things challenging and complicated for PS processors.

PVC DOWN TO FLAT

PVC prices were expected to sink 2¢/lb in November to January, as spot ethylene prices were dropping and contract ethylene prices were expected to settle 2¢/lb lower, which equates to a 1-1.5¢ cut in PVC production costs, according to Mark Kallman, RTi's v.p. of PVC and engineering resins. This accompanied slowed demand and reduced production rates. Meanwhile, suppliers issued price hikes of 3¢ for Jan. 1.

PVC Price Trends

Pipe	
DEC	JAN
↓ 2¢/lb	↔

Gen. Purpose	
DEC	JAN
↓ 2¢/lb	↔

Kallman saw the move as suppliers setting the stage to regain what they appear to be losing in first-quarter prices. Similarly, in her last 2019 report, *PCW* senior editor Donna Todd noted that suppliers were hedging their bets against the price drop with their new increase. "PVC suppliers, who have always been quick to point to ethylene pricing when they think it will help them push prices higher, will be facing a strong headwind early next year. By Dec 19, ethylene's spot price had fallen to 15.5¢/lb, a drop of 13.5¢/lb." She noted further pressure from Sasol's announcement that its Lake Charles, La., cracker had undergone a successful catalyst replacement and its operating rates were already up to 85-90% of nameplate capacity and on the increase.

PET PRICES FLAT TO DOWN

PET prices ended 2019 at 48¢/lb for railcars delivered east of the Rockies, down 17¢ (35.4%) since 2018, according to *PCW* senior editor Xavier Cronin. Prices started 2020 flat with weak demand as buyers assessed how much PET they would need over the next three months ahead of the warm-weather season, which typically brings higher demand in North America.

PET Price Trends

Bottle Grade	
DEC	JAN
↔	↓

PET markets were oversupplied with domestic resin and robust imports while demand was dropping as U.S.-based consumer brand companies used more recycled PET than in 2018. PT

Contraction Slows Among Processors

Improvement in fourth-quarter new orders suggests a production boost may be in the offing.

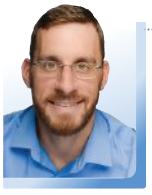
Gardner's Plastics Processing Index increased marginally to 46.7 in December, indicating a slowing contraction in plastics processing business activity. (Index readings above 50 indicate expanding activity while values below 50 indicate contracting activity. The farther away a reading is from 50 the greater the change in activity compared with the prior month.)

By Michael Guckes
Chief Economist/Director of Analytics

An analysis of the underlying components of the Index for the month found that new orders, production and exports propped up the Index, which is calculated as the average of its components. The Index was bogged down by employment, supplier deliveries and backlogs. All components for the month recorded contractionary activity levels.

Excluding October's new orders, every index component during the fourth quarter of 2019 was contractionary. No other time in the 8-yr history of the Index has seen such a broad-based contraction.

Gardner's Plastics Processing Index, which has reported contracting activity since July, identifies changes in the plastics market sooner than the Government's Industrial Production Index. The Federal Reserve's latest production data showed a November decline of 1.93% vs. the same month in 2018. The Gardner Plastics Processing Index is based on surveys conducted each month of subscribers to *Plastics Technology* Magazine.



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

Gardner Business Index: Plastics Processing

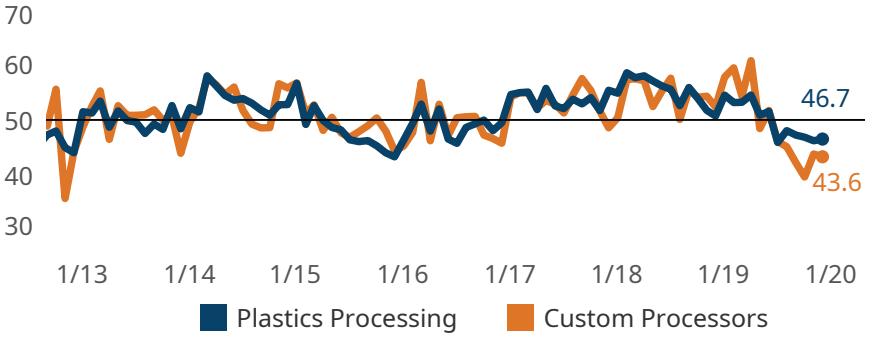


FIG 1

Plastics processing business activity, according to December's survey data, pointed to a moderating rate of contraction. New orders and production posted the highest readings among all components.

Plastics Processing in Midst of Rebalancing Production?

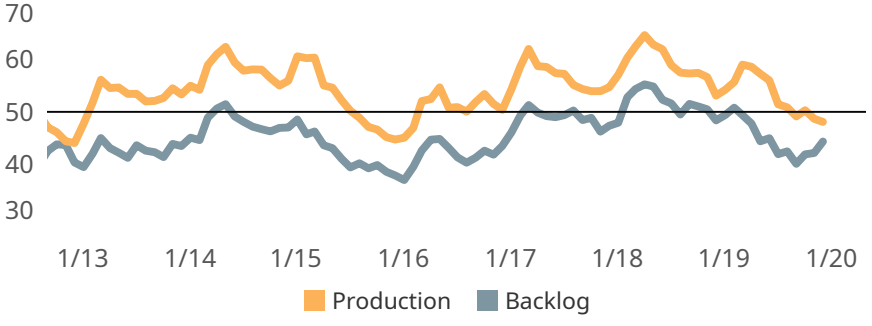


FIG 2

In the last three months of 2019, new orders posted higher monthly readings than production. This may in part explain the improvement in fourth-quarter backlogs, which touched a 3-yr low in September.

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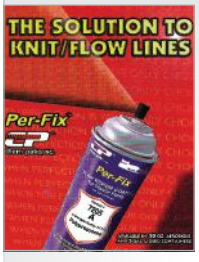

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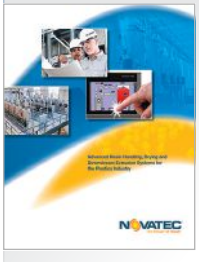

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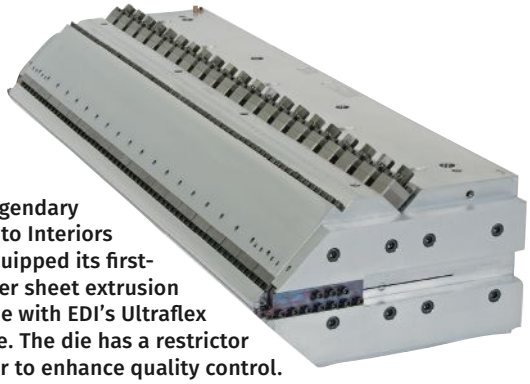
LEGENDARY AUTO INTERIORS LTD. — NEWARK, N.Y

Auto Interiors Leader Brings Extrusion In-House

For first time in its 35-yr history, Legendary Auto Interiors is producing its own PVC sheet for floor-mat line.



Legendary Auto Interiors equipped its first-ever sheet extrusion line with EDI's Ultraflex Die. The die has a restrictor bar to enhance quality control.

By Jim Callari
Editorial Director

A firm that for more than 35 years has helped owners of classic cars restore their vehicles' interiors to as-new condition has made its first venture into extrusion processing. About a year and a half ago, Legendary Auto Interiors Ltd., Newark, N.Y., worked with Nordson Corporation's EDI team on the installation of its first sheet extrusion line. The sheet line supports an undisclosed number of thermoforming machines at the firm, and plans are already on the drawing board to add more extrusion capacity.

Since its founding in 1983 by owner Martin Beckenbach, Legendary Auto Interiors (***legendaryautointeriors.com***) has produced hundreds of thousands of soft-trim components designed for retrofitting hundreds of vintage models, including many American "muscle cars" from the 1960s through the 1990s. Ranging from door panels and sun visors to upholstery and carpets, many of these components are cut, sewn, and thermoformed in-house.

Legendary Auto Interiors makes a range of floor mats, such as this one for Jeep.

Until now the company relied on outside firms to supply flexible PVC sheet for its floor-mat lines."We have had 30 years of experience in cutting, sewing, and thermoforming, but none in sheet extrusion," says Beckenbach. "The Nordson team played a critical role in helping us get up to speed and manufacture vinyl sheet to our requirements." Legendary runs flexible PVC sheet 55-in. wide (usable 53.5 in.) at varying thickness from 0.030 to 0.1875 in.

The extruder, a 3.5-in. Polytruder, was refurbished. Beckenbach says the rebuild included all electrical, electronic, and mechanical components, among them a multi-purpose mixing screw and new 100-hp AC motor and drive. Downstream, the firm restored in-house an old Johnson 54-in. system. States Beckenbach, "Every nut and bolt, the AC motors and drives, gears and gear boxes, chains, wiring, air and hydraulic systems, and heating/cooling system have been replaced or rebuilt with new. The roll stack, pull nip and winder have been restored. The cooling table, gantries and exhaust ventilation system were custom built to our requirements. Roll-stack rolls have been restored inside and out and rechromed."

The EDI Ultraflex sheet die was bought new and equipped with a restrictor bar to enhance control of sheet uniformity. Nordson provided start-up service, including hands-on training for how to operate the die, make adjustments, perform maintenance, and ensure operator safety. Recalls Rick Crank, Nordson service technician, "Once the die was installed, we showed the team how to heat the die properly to drive the moisture out of the heaters and then start up the extrusion line to purge remnant polymer through the system. After we explained how to adjust the die and zone temperatures to control the quality and thickness of the sheet product, operators produced quality sheet within the desired tolerance."

A key part of the start-up training involved taking full advantage of the restrictor bar, which is inside the die but is externally adjustable. Nordson equips sheet dies with restrictor bars for product thicknesses above 80 mils, notes James Winning, Nordson's regional sales manager. "Along with the (standard) flexible upper lip, the restrictor bar is used to adjust the thickness profile across the width of the die," Winning explains. "One of its benefits is to ensure uniformity in the melt-bank flow just before the nip point between the rolls. This uniformity reduces operational expenses and material consumption, preventing loss of material caused by surface irregularities." Beckenbach is pleased with the results. "The restrictor bar is working absolutely perfectly. It is so easy to use, and I can control the bank flow with perfection," he states.

Legendary Auto Interiors is using the extrusion line with the new Ultraflex die to produce its next-generation floor mats, along with custom vintage floor mats. In addition, the new extrusion capability will be used to manufacture various gauges of sheet for many other sewn, heat-sealed, and thermoformed products. PT

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