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JUNE 2020 № 6 VOL 66

Corrugated Sheet… All Boxed Up

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By Jim Callari, Editorial Director

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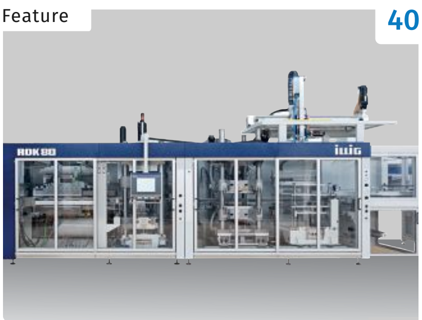

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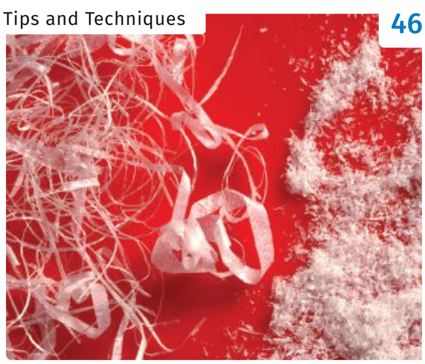

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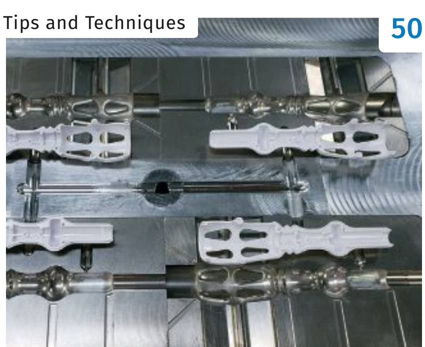

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By Scott Lammon, Phoenix Proto Technologies

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How the Coronavirus Crisis Will Change Plastics Processing

Manufacturing as a whole will emerge stronger, more nimble and in a better position to capitalize on opportunities as a result of the COVID-19 pandemic.

Jim Callari
Editorial Director

I'll admit, I'm a bit befuddled about the seemingly conflicting accounts I've been getting lately about what's going on in plastics processing. On the one hand, I'm regularly hearing stories and getting press releases about processors ramping up quickly to turn lines that had been running conventional plastics products into very specific personal protection equipment in the fight against the coronavirus pandemic. I'm hearing stories of molders calling their machine builders and even moldmakers to run parts for them due to their own capacity restraints. I'm reading about states like California, New York and others reversing bans on plastic grocery sacks. I'm being told of processors pre-buying resin to meet an expected surge in demand for their products. I'm hearing about processors buying new lines to meet demand. Good stuff, I'm thinking. Plastics processors are really busy.

Then during grocery shopping I'll make mental notes about what I see and don't see on the shelves and what it might mean for processors. Bread? Going fast—lots of bags used there. Juice? Dairy products? The shelves are not bare, but not fully stocked either. People are buying these necessities, so it stands to reason there must be demand for lots of bottles, caps, labels. Hand sanitizer? Seems like lots of the "green" products remain, but everything else is moving. Lots of bottles, pumps, gaskets have to be in the pipeline. Toilet paper? Good luck. But it's being made—lots of it—and the multi-roll packs are all wrapped in plastic. Fresh fruit and veggies going fast; lots of produce bags are likely being churned out. Done shopping, I loop around the store and see five trucks waiting to be unloaded. Lots of pallets. Lots of stretch film. Good stuff, I'm thinking, again. Plastics processors are really busy.

But then I'm also seeing results of our own research and forecasts by plastics industry economists and other pundits that paint a different picture—generally, that business conditions for processors will be down by 10% this year but experience a double-digit boost in 2021.

My first impulse to reconcile these two seemingly contradictory messages? Well, I tell myself, maybe I should have paid closer attention in Economics 101. But giving it more thought, it seems clear that business is strong in medical and packaging, and soft in other segments. Clearly these are not robust times for anyone supplying the automotive or housing markets.

So while the very near-term situation is nerve-wracking, I'm more optimistic about the future of plastics processing in North America than I've ever been in my 33-year career in plastics journalism. As grueling as it's been, I think North American manufacturing of all types will emerge stronger, more nimble and in a better position to capitalize on opportunities as a result of the COVID-19 pandemic.

But lessons must be learned first. Processors of all shapes and sizes will need to think more strategically about their supply chain. They will need to build in redundancies. They will need to put in place crisis-management initiatives that have not only a Plan B, but a Plan C and D. They will need to rethink about materials and spare-parts inventories. They will need to reconsider technologies that are more common in plastics-processing operations in other parts of the world, such as automation, lights-out manufacturing, and Industry 4.0 tools such as remote accessibility to processing machinery and predictive maintenance.

Processors will need to think more strategically about their supply chain and reconsider technologies that are more common in other parts of the world.

And then processors need to be ready for when OEMs and other customers make the inevitable, long-overdue decision to reverse their complex and tenuous supply chains and bring more manufacturing back to the U.S. They need to have invested in manufacturing.

Just promise me this: Pay more attention to the COVID-19 lesson than I did in Economics 101. PT

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DuPont Throttling Back Plastics Production by Close to 50%

In the first week of May, DuPont confirmed that it was temporarily shutting down close to 50% of its plastics production. This was in anticipation of further downslides in key industries such as automotive (which accounts for about 15% of the company's sales), aerospace, gas and oil, and construction.

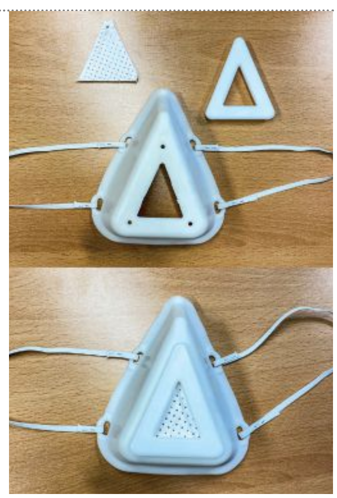
Dupont executive chairman and CEO Ed Breen said first-quarter global automotive builds were down 24%, and the most recent projections were for a 40% decline in the second quarter. He cited plans to start throttling back production or idling certain facilities—primarily in DuPont's Transportation & Industrial business segment, where profit margins would likely be reduced by 55% to 65%. The company has not disclosed which manufacturing sites will be affected.

Dow to Trim PE Production in the Americas

Dow is among the first PE suppliers to announce that it will throttle back production equating to about 10% of its global capacity in order to address the current supply/demand imbalance. The move includes idling for at least one month three PE plants: a solution PE train in Freeport, Texas; two gas-phase units in Seadrift, Texas; and one in Argentina; as well as two elastomer plants in Louisiana. The PE market was already becoming oversupplied as a result of new capacity that has been brought on stream over the last few years, with more on the way, before the coronavirus pandemic exacerbated the situation.

Dow CEO Jim Fitterling characterized first-quarter sales volumes as flat to slightly up in Packaging & Specialty Plastics, but the company is projecting second-quarter volumes for this segment as flat to 10% lower, with sales dropping 10% to 20%, partly due to expected declines in prices worldwide.

Although Dow sees weaker plastics demand for industrial and automotive applications, the company agrees with others in the industry that are optimistic that a positive turnaround on the industrial side of the economy could be seen in May to June as automotive plants reopen.



Kraiburg TPE Boosts Production of Medical Compounds to Meet Pandemic Demand

Spurred by the coronavirus crisis, Germany's Kraiburg TPE has boosted production of its specialty Thermolast M and K series medical TPE compounds. These materials are used in a range of medical applications from valves, connections and tubes for ventilators to face masks and respirators.

Plasma 'Glass' Barrier Coating Developed for Reusable PET Bottles

Micro-thin, glass-like silicon oxide (SiOx) coatings deposited by plasma-enhanced chemical vapor deposition (PECVD) have been used for years to provide gas barrier to PET bottles. However, such coatings are not resistant to the caustic-soda washing process

used to clean multi-trip PET bottles. So, until now, the desire in Europe to convert PET bottles from single-use to multi-use capability has been at odds with the gas-barrier requirements of beverages such as fruit juices, beer or carbonated soft drinks.

That conflict reportedly has been resolved by the development of a PECVD SiOx barrier coating that withstands caustic-soda washing. This is the result of an ongoing joint research project by the Institute for Plastics Processing (IKV) in Aachen, Germany, and German PET machinery maker KHS Corpoplast, which supplies a PECVD coating process called FreshSafe. The work is funded by the German Research Foundation.

M.R. Mold & Engineering Moves & Expands

Moldmaker M.R. Mold & Engineering Corp. has moved approximately four miles from its previous 18,000-ft² operation in Brea, Calif., to a new 23,000-ft² space in the same town, which includes room to add more injection molding machines in support of turnkey projects. The new space includes a tech center featuring six injection machines from 55 to 120 tons, which can run both LSR and standard thermoplastics.

100% Recyclable PET Vies to Replace Composite Cans

Ring Container Technologies, Oakland, Tenn., a blow molder of HDPE and PET packaging, announced the first customer for its new SmartCAN, a PET can designed to replace the common composite can with a much more easily recyclable alternative at comparable cost. John B. Sanfilippo & Son Inc. (JBSS), Elgin, Ill., whose brands include Fisher Nuts and Orchard Valley Harvest, has chosen SmartCAN for its dry snacks. The all-PET container replaces a composite can composed of paperboard with an aluminum foil interior facing and two metal ends.

SmartCAN is made by two-stage stretch-blow molding, with a dome on top that is trimmed off, a technique Ring Container has used on other products as a cost-effective means of making a wide-mouth container. The can is topped by a peel-off lidding foil (applied by the customer after filling) and by a snap-on HDPE lid (a screw-on version is available). The customer also provides the wrap-around label. The can has a slightly domed bottom, which provides stability during conveying. The can is designed to resist "paneling" deformation if filled with a warm product, says Cory VanLoocke, director of sales & business development. He also notes that SmartCAN is 35% lighter overall than a composite can of the same size (38.5 g vs. 59 g).

Ring Container Technologies previously supplied JBSS for years with PET wide-mouth jars as snack containers, but SmartCAN is the company's first "drop-in" replacement for composite cans that's adapted to existing filling lines. As noted by Tim Ferrel, v.p. of business development, SmartCAN addresses consumers' and brand owners' growing interest in recyclability and it also has the advantage of transparency, allowing the consumer to view the package contents. SmartCAN is currently available in two standard sizes—401 × 11 and 401 × 406 (30.5 and 28.6 fl oz, respectively)—though others will be available in the future. What's more, the PET can is customizable both in size and shape—"It doesn't have to be a simple cylinder, unlike a composite can," says Ferrel.

Ferrel sees numerous opportunities for SmartCAN beyond dry snacks, such as dried fruits and instant foods. Though the can is currently produced at two locations, it could in future be made at any of the company's 19 "focused plants" in the U.S., Canada and U.K. It does not require special production machinery, only tooling.

VanLoocke adds that the PET can could potentially incorporate up to 50% post-consumer recycle (PCR), enhancing its environmental advantages. He notes that a lifecycle analysis (LCA) performed by an independent third party (using the COMPASS LCA software tool) shows that SmartCAN produces 42% less greenhouse gas emissions using virgin PET, and 50% less with the addition of 30% PCR, than a composite can of the same size.

Butler-MacDonald Expands Recycling Capacity to Meet Increased Demand

Plastics recycler Butler-MacDonald of Indianapolis says the company is seeing an increase in business since the onset of the coronavirus pandemic. The company serves customers across the country as both a plastics toll processor—performing size reduction, polymer separation, metal and contaminant removal, pelletizing and compounding—as well as a supplier of high-quality regrind and reprocessed resins like HIPS, PP, LDPE, LLDPE, and HDPE. The company says that its March 2020 sales were up 10% over 2019.

Butler-MacDonald has stayed fully operational, running three shifts and also added capacity in the form of increased staff, extended hours (including Saturdays) and overtime. President Scott Johnson attributes the increased business primarily to expanded demand for plastics used in the fight against COVID-19, such as for medical face shields, disinfecting wipe containers and lids, bleach-bottle caps, etc. To a lesser extent, additional business has come to Butler-MacDonald as other smaller suppliers have either shut down or do not have the inventory to meet the increased demands of their customers.

The company has a long history of recovering high-quality polymers from waste plastics that most recyclers would consider unusable. Thus, Butler-MacDonald has been able to take in source materials that others won't and use it to create near-virgin-quality polymers to keep up with the sharp increase in demand.

Surging Demand for Hand-Sanitizer Dispensers Keeps Molding Machines Busy

It's an ill wind that blows no one any good. The old proverb rings true in the current coronavirus pandemic. Injection molder and contract manufacturer Sussex IM in Sussex, Wis., has around 20 of its 70 injection machines running 24/7 to produce wall-mounted dispensers for hand sanitizer. Each dispenser comprises 10 to 14 injection molded parts—of ABS, SAN, PC and acetal—as well as metal springs, magnets and motors. Assembly involves sonic welding and snap fits with both manual and automated steps.

Sussex CEO Keith Everson notes that when the H1N1 "swine flu" epidemic hit in 2009-2010, all these dispensers were made in Asia. Now, Sussex produces 50,000 to 70,000 dispensers per week, in 12 styles and various colors.

Everson sees this product as a candidate for the growing trend toward mass customization. He notes that wall dispensers for schools or companies could be decorated with their logos in limited runs economically using IML or digital printing. "There's a huge need for mass customization," Everson says, "and we're investing heavily in R&D and capital equipment to pursue it."

Protolabs' Pandemic Response: 4 Million Parts and Counting

Protolabs first felt the impact of the COVID-19 pandemic before it was a pandemic. In January, the global provider of custom prototypes and quick-turn-around parts began fielding calls from companies struggling to source production after normal suppliers in China shuttered as that country dealt with what was still a regional outbreak.

The supply-chain interruption intensified when on Monday Feb. 10, China's factories, which were expected to restart operations after the traditional two-week break following the Lunar New Year, remained shuttered. Says Gurvinder Singh, global product director for injection molding at Protolabs, "All of a sudden, everyone was scrambling because they had depleted all their safety stocks."

The company's coronavirus-related output includes testing kits, personal protective equipment (PPE), and lifesaving equipment (ventilator components). The unique challenge that the outbreak has posed to manufacturers both plays to Protolabs' strengths, notes Singh, and pushes it outside its comfort zone.

"Over all these years, we built our business on low volume and high mix," Singh says, "so what we're really good at is making 1000 molds per month." Given the urgency of the situation, Singh says Protolabs has bumped COVID-19-related jobs to the top of the lineup. This means for new molds, depending on the size of the part, the company is cutting tools within one day, and shipping part samples on average in three to five days.

While COVID-19 production has been high-mix, it has definitely not been low-volume. Protolabs often positions itself as bridge tooling. "But that's not the case right now," Singh says. That challenges the company's preference for running at very low machine utilization so that it has agility to address speed. Right now, that model is "a little strained," says Singh, "because we're doing a lot more to be able to support the COVID-19-related jobs." But its low-utilization model is a key reason why Protolabs was able to quickly scale up to help customers. "We didn't have our machines tied up in long-running jobs."

320 L Hydrogen Tank Liner Blow Molded in Nylon

Hydrogen-gas-powered drive and production systems are being used in heavy-goods transport, local public transport, shipbuilding and the aircraft industry. In the future, they may prove economically feasible for passenger-car fuel cells. For some time, Kautex in Germany has been working on composite pressure vessels (CPVs) for compressed natural gas (CNG), liquefied petroleum gas (LPG), and hydrogen containment, which are produced by filament winding a continuous-fiber thermoset composite shell over a blow molded liner. Most recently, Kautex development engineers claimed to set a new benchmark by blow molding for the first time a 320-liter cylindrical liner more than 2 meters long and around 500 mm in diam.

Hydrogen, the smallest molecule in nature, can diffuse through virtually every plastic material, Kautex notes. Special polyamides (nylons) have the best hydrogen barrier properties, but their low melt strength has made them difficult to process in large-part blow molding. Newly developed grades and a special extrusion technique now make it possible for the first time to produce hydrogen liners in sizes suitable for industrial applications, Kautex states. The company considers both the material and the processing technology to be proprietary information for this development project.

"Producing a liner of this size from polyamide has been a major challenge. The work we are doing here is truly pioneering," says Abdellah El Bouchfrati, head of Kautex's Composite Business Development. The hydrogen CPV tanks are designed for an operating pressure of 700 bar (10,153 psi) and burst pressure of 1750 bar (25,382 psi). They must also withstand temperatures from -60 C to 120 C (-76 F to 248 F).

The 320 L liner was produced on a Kautex KBS241 accumulator-head extrusion blow molding machine, which can have a single head of 25 to 60 L capacity and a clamp of 120 or 150 metric tons. "The liner size we have now achieved is just the start," says Bouchfrati. "We are confident that, in the future, we will be able to use this method to produce considerably larger liners for hydrogen pressure vessels."

Among recently introduced materials for hydrogen fuel tanks, DSM introduced in 2017 a nylon 6 based material, Akulon Fuel Lock; and in 2014, Ube Industries brought out Ube Nylon 1218IU, a nylon 6 that is used in the hydrogen tanks on the Toyota Mirai fuel-cell sedan.

Ineos and Plastic Energy Collaborate on Chemical Recycling

Ineos Olefins & Polymers and recycling firm Plastic Energy Ltd. are collaborating on building a recycling facility in the U.K., slated for startup by end of 2023, that will convert waste plastics into chemicals to make new premium polyolefins. Plastic Energy's patented Thermal Anaerobic Conversion (TAC) technology breaks down previously unrecyclable plastic waste to its basic molecules, yielding a product called TACoil. This can be used by many Ineos crackers to produce traditional feedstocks to make new, highly pure polyolefins for food packaging, medical products, automotive parts and water pipes. Ineos says the facility will process a range of mixed and multi-layered plastic waste composed of LDPE, LLDPE, HDPE, PP, and some PS. The process allows these materials to be processed together without the need for segregation by plastic types or colors.

Initial trials of Plastic Energy's recycling process have been completed successfully in Germany. The plastics made from this trial will now be used by selected customers and brands to demonstrate the benefits of the process. The company's TAC technology reportedly makes it possible to produce final product with specifications identical to virgin material while removing all contamination.

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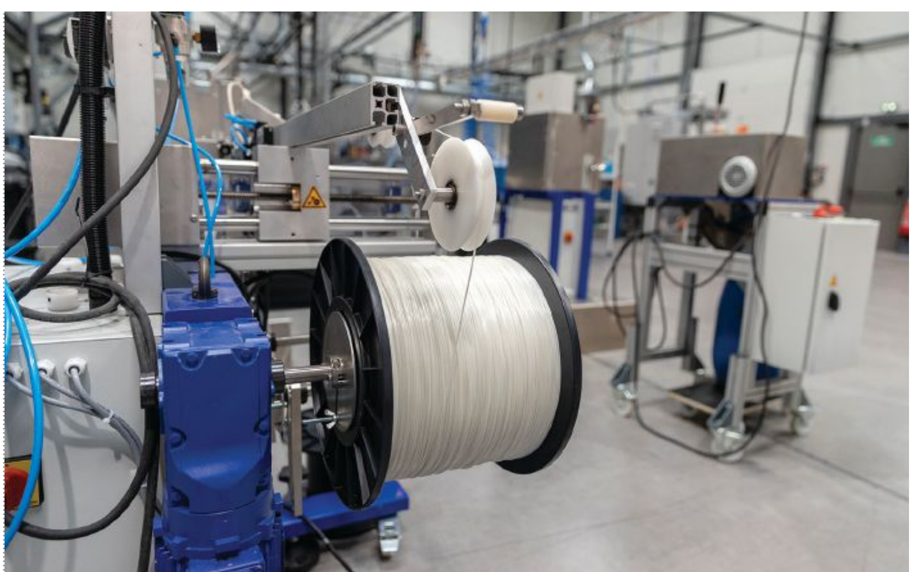
3D Printing Helps Close the Loop for Armor's Circular Economy

Manufacturing 3D printing filament was first a way for Armor to recycle its own reclaimed plastic waste. But now, this business unit is helping to close the loop on sustainability for plastic 3D printed products.

By Stephanie Hendrixson
Senior Editor

With the rising buzz around sustainability and green initiatives, selling 3D printing filament made from recycled materials seems like a savvy business choice today. Yet in 2014 when The Armor Group launched its first recycled filament — made from used inkjet printer cartridges — the product was a little ahead of its time.


After collecting plastic waste and receiving the cleaned and pelletized material back from processors, Armor 3D extrudes the filament and packages it for sale. (Photo: oioo.fr)

"There wasn't much need or demand for recycled materials four or five years ago," says Pierre-Antoine Pluvinage, global business director of Armor's 3D printing unit. "There were already lots of suppliers of conventional materials, and the industry was more looking into technical and high-performance materials to serve production of final parts."

Another person might have been discouraged by this early lack of demand for the product, but Pluvinage was already looking to the future. He and others saw that 3D printing offered not just a new potential business opportunity, but a step forward in Armor's ongoing pursuit of the circular economy. Today, that initial effort to find a use for internal scrap is rapidly becoming a much larger endeavor, one that could help shape the future of plastics manufacturing.

A CIRCULAR ECONOMY FROM 2D TO 3D PRINTING

In a conventional linear economy, resources are converted into products and sold on to consumers. OEMs source raw materials, design and manufacture their products, and then market and ship them to consumers. Once a product is purchased, though, its value chain effectively ends; the manufacturer no longer has a vested interest in that product or the materials it contains.

A circular economy, by contrast, is one that closes this loop. In this model, the manufacturer assumes responsibility for the product from its creation through the end of its life. When an item is no longer functional or needed, its maker must have a plan for how that used material will be recaptured and then repurposed or recycled into something new.

Armor has been pursuing a closed-loop circular economy for more than a decade. Headquartered in France, the company is a provider of printer cartridges, thermal tape, industrial inks and other 2D printing supplies. Sustainability efforts, including reclaiming used product, have been a part of its corporate social responsibility platform for years. In 2006, one of these initiatives was collecting used inkjet cartridges for the purpose of remanufacturing them into fresh ones. The idea was a good one, but the system couldn't handle all the waste generated. Only about 4 out of 10 recovered cartridges were suitable for reuse, which still left behind a significant amount of scrap.

It was Pluvinage (then strategic project manager) who proposed transforming the 2D printing cartridges into 3D printing filament. As already described, the recycled filament wasn't an overnight success in 2014. But it was a start, and one that helped the company close the loop on an existing product while exploring a new business opportunity.

> *"3D printer users see waste with their own eyes, and become more conscious of better reuse of materials."*

Shortly after the launch of that first material, the newly established Armor 3D business unit led by Pluvinage also introduced lines of technical and high-performance 3D printing filaments made from virgin stock, under the Kimya brand. (The brand's name comes from an Arabic word that is the root of "alchemy" — a fitting moniker.)

Those conventional materials provided a foothold for entry into the 3D printing marketplace. Today Kimya encompasses a "three-legged approach" says Ryan Heitkamp, Armor v.p. of operations in North America. The company continues to offer standard formulations of Kimya-branded filament, while Kimya Lab creates custom formulations and Kimya Factory provides 3D printing services. Filament is produced in France, with production due to expand to the United States in 2020.

3D PRINTING IS PART OF BOTH THE PROBLEM AND THE SOLUTION

Current Kimya filament offerings include materials made from both virgin and recycled stock. Demand for the latter has grown in recent years, Pluvinage says, with more additive manufacturers not only accepting but now seeking out recycled materials.

He attributes this shift to increasing awareness about sustainability and waste in general, but also to how 3D printing's rise has democratized manufacturing. When people bring 3D printers into their homes, schools and offices, they *become* manufacturers — and then have to grapple with the same challenges as manufacturers, including dealing with waste from failed prints or items no longer needed. The same happens in manufacturing facilities that are ►

suddenly able to print items at a moment's notice, and find themselves accumulating more scrap as a result.

"Even though 3D printing is about making parts using only the material you need, you still make waste like prototypes and items that won't be needed long-term. Prototyping is still 70% to 80% of the market today," Pluvinage says. "Companies now see the waste being produced easily, quickly and everywhere. 3D printer users see it with their own eyes, and become more conscious of better reuse of materials and what you do with prints afterward."

Manufacturers are under growing pressure to operate more sustainably even as this scrap becomes more conspicuous. But this pressure also potentially makes them more open to exploring 3D printing as an alternative production method or as a means of dealing with scrap. Armor 3D has seen an uptick in manufacturers requesting custom materials made from their own post-industrial waste. In such situations, the company can pull together its recycling and materials expertise to create a suitable solution.

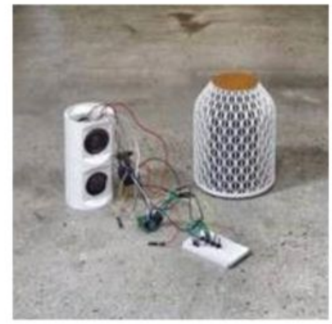
"We are about to launch a program in France to collect waste from customers, at the end of the lifecycle of our 3D printing materials."

As a way of scaling this scrap-to-filament model, the company launched a recycling program in early 2019 to reclaim spools, filament scraps and unneeded prints from its largest filament customers in France. L'Oreal is one example — post-production plastic waste from the personal-care company is converted into filament that it can then use to print future prototypes and tooling.

Other recycling clients have contributed waste like flexible TPU tubes, PLA food packaging, and even organic materials like leather and oyster shells. These materials could be converted to return to the customer, or be used in a standard Kimya recycled filament. In addition to post-industrial scrap collected from outside manufacturers, the company also uses post-consumer plastic waste like yogurt cups as well as its own scrap and reclaimed product, like those original cartridges. In each case, Armor 3D collects the scrap materials, transfers them to a third-party processor, and then compounds and extrudes the filament itself to return to the customer or release into the marketplace.

CLOSING THE LOOP ON PLASTIC PRODUCTS

Manufacturing 3D printing filament from recycled scrap is a step in the right direction. So, too, is helping other companies reimagine their waste materials as potential feedstock rather than trash. But to truly close the loop on a circular economy, manufacturers will have to deal with post-consumer waste — used product — as well. When I spoke to Pluvinage and Heitkamp in January 2020, Armor 3D was already on a path to tackle this challenge.



3D printed products like these made with Kimya filament could one day be recaptured and recycled back into filament, closing the loop on the circular economy for the material.

"We are about to launch a program in France to start to collect waste from customers, at the end of the lifecycle of our 3D printing materials," Pluvinage says. Ultimately Armor will collect and recycle not only 3D printing waste from its customers, but also the used 3D printed products that they make and sell. It is possible that future product lines could be made from Kimya recycled filament and recaptured at the end of their lifecycle to be converted back into that filament. This is a twist on the typically proposed circular economy scenario, with the material supplier rather than the product manufacturer taking responsibility for future waste, but it's a strategy that Armor is well-positioned to execute.

Will other manufacturers follow suit? What will it take to close the loop on a circular economy for plastics? Once again, the challenge that Armor sees is mindset. Manufacturers must get used to recycling their waste and reclaiming used product; likewise, consumers must get used to returning unwanted items.

"We have to make it simple all the way from the consumer to the manufacturer," Heitkamp says. "That's where sustainability will unlock itself."

Pluvinage echoes the sentiment, pointing out that the barriers are not primarily technological, but psychological. "Companies *will* find a solution, but it's a matter of deciding," he says. "We can't consume like we did before when we saw resources as 'unlimited.' We sense and feel now that they are limited, and this is making us move and think differently. Technology is here to help."

3D PRINTING AND SUSTAINABILITY

This article is part of an ongoing project to report on the intersection between 3D printing and sustainability at sister publication *Additive Manufacturing*. Find related stories at ***gbm.media/3dpsustain***.

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Republic
Machine

Sheet Processor Adds Capacity in Coronavirus Fight

Laminex is venturing into APET for the first time to make PPE in Mexico, after purchasing one of PTi's demo production lines. The turnkey system will ultimately be used by Laminex for its packaging products.

Who are those masked men? To battle against COVID-19, sheet processor Laminex bought a demo PET sheet line from PTi that will at first make PPE. Pictured l-r are Robert Prewitt, plant manager for Laminex's Texas facility; Alejandro Jimenez, plant manager, Laminex Mexico; and Jesus Avelar, PTi sales representative.

By Jim Callari
Editorial Director

The global coronavirus pandemic last month brought one of Mexico's leading sheet processors to Aurora, Ill., to buy a new extrusion line. Laminados Extruídos Plásticos (Laminex) made the trip to Processing Technologies International (PTi) to buy one of the machine builder's demonstration sheet extrusion lines right off the floor of its Technology Development Center. Laminex will use the new line initially to make personal protection equipment (PPE) for face shields and screening at one of its plants in Guadalajara, Mexico.

The line, which is expected to be fully operational by the end of July, will then be transitioned to support Laminex's activities in supplying sheet to a wide range of industries, including packaging, automotive, point-of-purchase displays, refrigeration and construction.

"We don't need a dryer and crystallizer, so that saved us money, cuts down on maintenance and improves the overall efficiency of our process."

At the heart of the system Laminex bought is a 85-mm, 52:1 L/D HVTSE (high-vacuum twin-screw extruder), which PTi furnishes through a long-time agreement with Italy's Luigi Bandera. The line will also be equipped with PTi's G-Series GSVD661824 sheet takeoff unit and ACW6640/2 dual-position, differential shaft-winding system. It offers an output capacity of 2200 lb/hr. The line is also equipped with a Nordson die and a Doteco feeding system.

Laminex was founded in 1993 and starting by running PS sheet for the printing industry. Over the years it expanded its product line to include PE, PS, PP, ABS, PETG and hollow PP sheet. With the PTi HVTSE DryerLess system, Laminex will be running APET sheet for the first time. "We see a growing need for APET sheet in the Mexican market," says Robert Prewitt, plant manager for Laminex's 25,000 ft^2 facility in Mansfield, Tex. "And we are looking to grow with the market."

A wide range of resins can be run on the HVTSE system without the need for screw changes, which Laminex considers ideal since it runs a handful of different materials in its day-to-day operations. The processor also found appealing that it's unnecessary to pretreat (crystallize and dry) material; instead, a high-vacuum system removes moisture up to 12000+ ppm. This technology also allows processing up to 100% regrind, a critical component for energy savings and recycling. "We were impressed with the technology," Prewitt notes. "We don't need a dryer and crystallizer, so that saved us money, cuts down on maintenance and improves the overall efficiency of our process." Prewitt says Laminex will be running sheet in thicknesses from 20 to 30 mils.

The line Laminex bought was one of two demonstration lines running in the PTi TDC facility, the second of which is a Super G HighSpeed Model 3000-36D (75-mm) system with an output capacity for PP of up to 2500 lb/hr.

PTi is currently in the advanced stages of building a demo production line that will replace the one Laminex bought. Matt Banach, PTI's v.p. of sales and marketing, says it will be their next

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Laminex will make face shields and screens from its PTi HVTSE DryerLess system, and later APET sheet for packaging and other applications.

Intended to make PPE at first, new line Laminex bought from PTi is a 85-mm, 52:1 L/D HVTSE (high-vacuum twin-screw extruder) furnished with PTi's G-Series GSVD661824 sheet takeoff and ACW6640/2 dual-position, differential shaft-winding system.

generation MultiResn DryerLess technology plus a J-roll stack with auxiliary cooling rolls, edge-trim-recovery system, and a range of other components. PTi says the TDC permits customers to conduct sheet extrusion trials on a brand-new, full-scale production equipment, often using their own materials to demonstrate the overall equipment performance and related features.

MATERIALS

PART 3

Annealing Tips for Semicrystalline Polymers

For these polymers, annealing is done to establish a level of crystallinity that cannot be practically obtained within the parameters of a normal molding cycle. Here's some guidance on setting annealing time and temperature.

By Mike Sepe

Annealing of amorphous polymers is typically performed to reduce the internal stress in a part below the levels achievable during the molding process. However, in semicrystalline polymers the objective of annealing is to establish a level of crystallinity that cannot be practically obtained within the parameters of a normal molding cycle.

Each semicrystalline polymer has the ability to crystallize to a certain extent that depends upon the chemical structure of the polymer chain. HDPE has a flexible, streamlined chain that allows for efficient crystallization to a very high percentage, while a material like PEEK attains a modest level of crystallinity even under the most carefully controlled process conditions.

Optimum levels of crystallinity enhance a wide range of properties that include strength, modulus, creep and fatigue resistance, and dimensional stability. This last property is very important in applications where very tight tolerances must be maintained in parts that will be used at elevated temperatures. Crystallization is controlled by cooling rate and occurs at a rapid rate during the fabrication process. To achieve what is considered to be an optimal level of crystallization, the temperature of the mold must be maintained above the glass-transition temperature of the polymer. This promotes a level of molecular mobility that allows crystals to form.

One determining factor in selecting an annealing temperature is the maximum temperature to which the part will be exposed in application.

Crystallization can only occur in the temperature window below the crystalline melting point and above the glass-transition temperature (T_g). Consider PPS as an example. The melting point of PPS is 280 C (536 F) while the T_g is approximately 130 C (266 F) when determined from a particular dynamic mechanical property. Therefore, the guideline for setting the mold temperature to ensure proper crystallization is a minimum of 135 C (275 F). Processors that pay attention to this requirement will typically select mold temperatures of 135-150 C (275-302 F). But even when this parameter is properly controlled, the relatively rapid rate of cooling involved in melt processing and the limited time that the part spends in the mold will limit the achievement of the crystalline structure to about 90% of what is theoretically obtainable.

We know that the rate of crystallization is not constant across the entire temperature range between T_g and T_m (melting point). In many polymers, crystals form most quickly at a temperature approximately midway between these two extremes. Therefore, to achieve the most efficient rate of crystallization in PPS, we would use a mold temperature of 205 C (401 F). This is a more challenging mold temperature to maintain, and the difference in mechanical properties between a part produced at this higher mold temperature and one produced at the lower mold temperature is relatively small. Therefore, the typical practice is to use the lower mold temperature.

However, if the molded part will need to operate at 200 C, exposure to this application temperature will produce additional crystallization while the product is in use. We know that as materials crystallize, they shrink. So, a part that goes into the field molded to the proper dimensions and is then exposed to very high application temperatures may change size while in use. If this dimensional change creates a functional problem for the product, then it is necessary to stabilize the dimensions of the part before it goes into use. This is done through annealing.

In amorphous polymers the annealing temperature needs to approach the T_g of the polymer. However, to produce the desired result when annealing a semicrystalline material, the annealing temperature must exceed the T_g of the polymer. The time required will depend upon the part wall thickness, as is the case for amorphous polymers. But the other factor that influences the required time will be the annealing temperature.

As mentioned above, the target annealing temperature is often the midpoint between T_g and T_m. Lower temperatures ►

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The target annealing temperature is often the midpoint between Tg and Tm. Lower temperatures will require a longer annealing time. (Photo: Annealing oven from Grieve Corp.)

will require a longer annealing time. Another determining factor in selecting an annealing temperature is the maximum temperature to which the part will be exposed in application. If a part is annealed at 200 C but is then used at 225 C, new crystals will form at the higher use temperature that were not formed during the annealing process. This will produce additional dimensional changes that may be problematic. Therefore, the annealing temperature should be equal to or slightly greater than the maximum temperature at which the part will be used. Just as amorphous polymers cannot withstand annealing temperatures above their T_g, semicrystalline polymers cannot be annealed at temperatures that exceed their crystalline melting point.

Annealing time is best established experimentally for a particular part geometry. In amorphous polymers the test used to establish that the objective of annealing has been met is the solvent test that measures residual stress in the part. In semicrystalline resins the benchmark is dimensional stability. A properly annealed part molded in a semicrystalline material should be able to withstand exposure to a time-temperature routine representative of a worst-case application environment without exhibiting an additional change in dimensions.

A good example of this principle can be illustrated for parts designed for exposure to a temperature of 85 C (185 F) for periods of up to 8 hr. An assembly produced from two component parts that had each been annealed at 70 C (158 F) for 1 hr exhibited dimensional changes upon exposure to the application conditions. These changes caused the parts to bind when the assembly was operated, making it non-functional. Annealing at 110 C for the same 1-hr period resulted in assemblies that displayed no change in function after exposure to the application environment.

There is another reason for selecting an annealing temperature that exceeds the highest anticipated use temperature. Crystals that are formed while a material is in the solid state are not as large or as perfect as those that form as the material cools from the melt. Consequently, they do not have the same properties and they do not impart the same benefits to the overall structure of the material. Specifically, crystals that are formed at a particular annealing temperature will melt at a temperature just a few degrees above the temperature at which they were produced. Therefore, crystals that are produced at a temperature below the maximum use temperature of the part will not survive that exposure and are not useful.

Because additional shrinkage during annealing of a semicrystalline material is inevitable, the dimensions of the as-molded part must be larger than the final target dimensions. This may require that parts be molded out of print so that they can meet the print once they have gone through the annealing process. It is important, therefore, that a relationship be established between the as-molded dimensions and the annealed dimensions.

Annealing temperatures for many semicrystalline polymers are high enough to produce other effects on the polymer that are potentially damaging. For example, the midpoint between the T_g and the T_m of nylon 66 is 160 C (320 F). At this temperature nylon can rapidly oxidize. This can cause a change in the color of the material, but more importantly it can result in a permanent loss in mechanical properties, particularly those associated with ductility. Consequently, for materials like nylons annealing is best performed either in an inert atmosphere, under vacuum, or in a fluid that will act as an oxygen barrier and will not alter the properties of the material. For example, nylon parts can be annealed in hot mineral oil to prevent oxidation and improve heat transfer. Because mineral oil is nonpolar, the nylon will not absorb the oil and no plasticizing effects will be observed.

Annealing time is best established experimentally for a particular part geometry.

Annealing in semicrystalline materials is ideally done in order to perfect the structure of a part that has already been molded according to optimal procedures. However, some processors use the annealing strategy to avoid the demands of the high mold temperatures needed to properly crystallize high-performance materials such as PPS, PEEK, and PPA. This can bring about serious deficiencies in part performance and significant difficulties with process control. In our next article we will look at these problems more closely.

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INJECTION MOLDING

Fundamentals of Proper Press Shutdown

Press shutdown procedures have a significant impact on achieving smooth machine startups and restarts to improve uptime. Here's a procedure you might want to deploy in your molding operation.

By Garrett MacKenzie

In the fast-paced world of injection molding, the key drivers of a plant's profits are downtime, efficiencies and scrap. A company's success relies heavily upon quick and efficient startups. Elimination and avoidance of unplanned downtime events also plays a critical part in profitability.

Press shutdown procedures have a significant effect on achieving smooth machine startups and restarts. Moreover, presses shut down poorly quite often lead to process failures and downtime. This article will outline potential downtime events that have a direct relationship with poorly performed press stops. It will also provide a solid approach based on time that will help to reduce, and in most cases eliminate, scrap and downtime associated with press shutdown.

Failing to pull back the carriage at shutdown can lead to blowback when the press is restarted.

SCREW FAILURES

A poor approach to screws is frequently the cause of unneeded downtime and failed startups. Shutting down without running the screw dry can lead to feedthroat bridging, which can require hours of servicing to remove melted plastic from the throat.

Leaving the carriage forward for long periods of time can lead to nozzle drool and material blowback on restart. Any time a press is shut down, it is wise to back the carriage off, remove material from the barrel, and retract the screw 1 in. to release pressure and help prevent drooling. At this point, the sprue bushing should be inspected and cleaned in preparation for restart.

Presses shut down poorly quite often lead to process failures and downtime.

The nature of some materials, such as nylon, acetal and PVC, may require purging the screw with an inert material like PP, PS or a purge compound to prevent degradation. Over time, that degraded material can cause screw and/or tip breakage, and even lock up the screw and barrel. That could ultimately necessitate replacement of both. It goes without saying that the costs and downtime associated with these types of repairs can be astronomical.

HOT-RUNNER APPROACH

Hot-runner care is crucial for mold-damage prevention. Hot runners that are left on for extended periods of time can perform poorly due to overbaked and/or degraded materials. In the case of polycarbonate, long heat exposure can cause contamination issues that lead to huge scrap events. High fiberglass content left in the hot runner can lead to plugged drops. Any one of these situations can lead to extra mold changes and unplanned mold maintenance.

MOLD SHUTDOWN

Any time mold activity goes idle, it is time for mold inspection and care. Slide slots and ejector/ guide pins should be inspected for damage, galling, and lubrication. In-press mold storage is vital if the press is to be down for the longer term. The mold should be left with mold halves touching but not under pressure.

WATER SHORTFALLS

Water shutdown is crucial to downtime and damage prevention. Long-term shutdowns can lead to unnoticed leaks. When a mold isn't moving, water performance changes. This type of leak can lead to rust, which forces a mold to be pulled for service. Rust on a textured

►

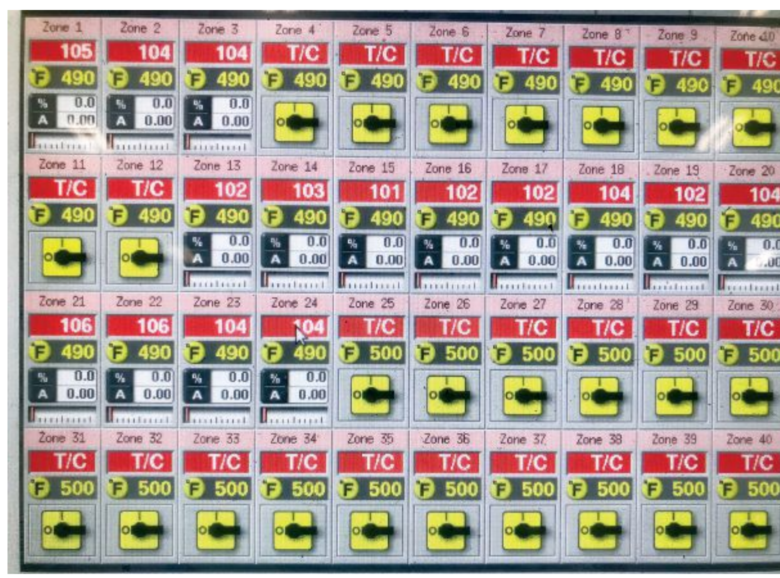
surface can cost thousands in tool repair and downtime.

Failing to close the slide on shutdown can lead to a bridged throat and excessive downtime.

Purge should be removed from press bed to prevent sticking. Keep your press bed and area clean and free of debris. Best practice is to treat every day as if the customer will walk the floor at any minute.

THREE-STAGE SHUTDOWN PROCEDURE

The following procedures outline proper purging and shutdown of presses. There are three basic time frames that should determine the technician's actions. These procedures have been developed based on using materials such as nylon. The purpose here is to reduce the number of purge approaches, while also instilling good shutdown habits. The cost of extra purge puddles is much cheaper than the cost of machine or mold repair and downtime associated with poor shutdown practices.



Hot-runner controllers should be turned off during long shutdown periods. This will help to prevent degradation in the hot-runner manifold.

If the press will be down for 30 min or less:

- Retract carriage to separate tip from bushing.
- Inspect tip for blowback.
- Run screw forward to remove shot from barrel.
- With screw empty, suck screw back 1 in.
- Remove purge from press bed.

If downtime length is unknown or longer than 30 min but less than 4 hr:

- Retract carriage to separate tip from bushing.
- Inspect tip for blowback.
- Purge throat and barrel completely dry with polypropylene.
- With screw empty, suck screw back 1 in.
- Shut off hot runner.
- Remove purge from press bed.

If downtime will be 4 hr or full shift:

- Retract carriage to separate tip from bushing.
- Inspect tip for blowback.
- Purge throat and barrel completely dry with PP.
- With screw empty, suck screw back 1 in.
- Shut off hot runner.
- Spray mold lightly with rust preventative.
- Close mold, not under tonnage, with mold faces touching.
- Shut off water at main valves.
- Remove purge from press bed.

Weekend Shutdown:

- Retract carriage to separate tip from bushing.
- Inspect tip for blowback.
- Purge throat and barrel completely dry with PP.
- With screw empty, suck screw back 1 in.
- Shut off hot runner.
- Spray mold with rust preventative.
- Close mold, not under tonnage, with mold faces touching.
- Shut off water at main valves.
- Bank dryer at 100 F.

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EXTRUSION

The Importance of Zone 1 Barrel Temperature

Tweaking the temperature settings of the first barrel zones may not yield the desired result. In fact, they may yield the opposite. Here's why.

The sooner you can start melting, the more efficient the whole process, as it extends the effective screw length. (Photo: Davis-Standard)

By Jim Frankland

Perhaps the most misunderstood part of the extrusion process is the effectiveness of the barrel temperature in Zone 1. In the feed section of the extruder, the solids are always well below the melt temperature (unless melt fed) and the screw conveys them forward in auger-like fashion. They become compacted from the drag and frictional forces acting upon the particles. During compression, some pressure develops in the solid polymer as it is forced into intimate contact with the barrel wall.

With the screw rotation and resulting sliding/shearing of the compacted mass against the barrel wall, as well as some conducted heat from the barrel, the solids adjacent to the barrel wall accumulate enough energy to form a thin layer of melted polymer on that surface. This usually occurs from one to three diameters after the cooled feedthroat and is often referred to as the "delay in melting." From that point the forwarding force or output depends on that thin film dragging the solids underneath.

The majority of the energy to initiate melting comes from the frictional drag of the polymer against the barrel wall.

Although the conducted heat from the barrel contributes to the initial formation of melt layer or film, the majority of the energy to initiate melting comes from the frictional drag of the polymer against the barrel wall. That's because polymers are very poor conductors of heat, evidenced by the fact that it often takes several hours to melt the polymer in a cold extruder before it can even be started up.

Once initiated, the melt film becomes an intermediate layer between the barrel and the underlying solids. That layer absorbs most of the energy from the drive. Eventually a melt pool is formed on the pushing side of the flight and melting progresses. As a result, the first barrel zone does not always react as you might expect. Cooling Zone 1 below the melting point of the particular polymer delays melt formation and thereby effectively shortens the melting length of the extruder—and likely the output. Since the barrel is highly thermally conductive compared with the polymer, it pulls heat from the film if the temperature is set below the melting temperature.

Conversely, if the barrel is heated well above the melting point, it lowers the viscosity in the film, reducing its shear stress, resulting in a reduction in melting rate and output. Both reactions can be the opposite of the operator's likely intentions and only serve to reduce the melting and potential output. If you look at the force balance in this system, the formation and viscosity of the initial melt at the barrel wall determine the output of the extruder. Obviously the rate it goes through Zone 1 determines the final rate of extrusion.

The power going into the polymer from the extruder drive is many times the total wattage of all the barrel heaters of most commercial-sized extruders, even under full heating power. So the barrel heaters are essentially for startup and some trimming ►

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of the barrel-temperature profile. That's why I prefer the use of an "adiabatic" approach to barrel settings, with the exception of the first barrel zone, which can be instrumental in initializing the melt-film generation and output. The sooner you can start melting, the more efficient the whole process, as it extends the effective screw length.

Adiabatic approach refers to a barrel-temperature profile that does not add or remove much heat from the melt film once it's formed. In other words, the temperature controls after Zone 1 are set so that they essentially do minimal heating or cooling after startup.

Zone 1 also has an additional effect on the feed rate by transferring heat to the feedthroat. A warmer throat improves polymer-to-barrel friction, resulting in greater feed rates and better stability. A cold feedthroat pulls heat from the beginning of Zone 1, reducing early polymer-to-barrel friction and early melting, which determine the output. A good setting for Zone 1 is a temperature slightly above the melting point of the polymer. That does two things: It eliminates removing heat at the initiation of melting; and it prevents greatly reducing the viscosity of the melt against the barrel.

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TOOLING

PART 4 How to Properly Size Gates, Runners and Sprues

How to get the sprue, runner and gate sizes close to ideal the first time around.

By Jim Fattori

In part one of this series (in March) I discussed the importance of proper gate depths and gate widths. In part 2 (April) I covered two different types of gates, as well as gate land length and gate-freeze time. In part 3 (May) I discussed edge gates and runner sizes. This month I will discuss runner surface finish; dispelling some bad advice; and how to size the sprue bushing.

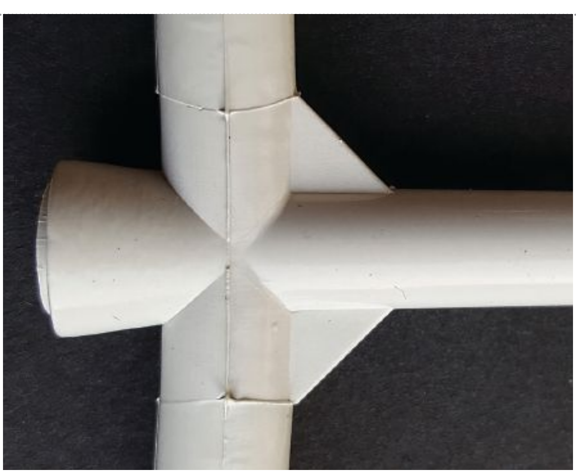
Several industry experts say the runner channels should be polished to the same surface finish as the cavity, or between 5 and 50 micro-inches (RMS). This reportedly is necessary to minimize the pressure drop and help with release from the mold. Even if this theory were true, I would suspect it would be almost immeasurable and most likely inconsequential.

Another industry expert doesn't believe a runner needs to be polished at all, unless it is required for ejection purposes. He says the surface finish doesn't matter because plastic exhibits fountain flow. As molten plastic flows down a runner channel, it sticks and solidifies to the cold surfaces of the mold. Once it sticks, it has zero velocity. The center of the melt continues to flow—like a fountain—continually depositing additional material from the hot center to the cold outer walls.

> ***Draw polish the sprue bushing and any type of subgate.***

I have an alternate perspective on whether or not you should polish the runner channels. There is a direct correlation between surface finish and surface area. If a runner channel has deep cutter marks, it has an increased surface area, as compared to one that was polished. Having a rough surface finish in the thicker runner sections could be helpful in reducing the solidification time. Conversely, having a smooth surface finish on the thinner runner branch feeding the gate could be helpful to ensure the flow channel doesn't solidify too quickly, which can affect the ability to pack out the cavities. The only negative aspect I can think of related to *not* polishing a runner system is that a runner system full of cutter marks is not going to *appear* to be finished by the customer.

Whatever your belief, you must draw polish the sprue bushing and any type of subgate, to assist in their release. This polishing requirement does not apply to all materials. Polyolefins and most elastomers perform better with a light vapor-honed finish—after you remove any cutter marks. The stipple finish reduces the surface tension for easier release.



Having a large mass at the parting line is undesirable, but reducing the sprue's orifice size is worse. Better choices include reducing the length or internal taper of the sprue bushing, using a bushing made of a copper alloy, increasing cooling around the bushing, adding gussets adjoining the sprue to the primary runner (shown here), or replacing the cold sprue with a hot bushing.

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DETERMINE THE SPRUE 'O' DIMENSION

In researching this article, I found very little information on how to determine the best orifice size for a sprue bushing. That seemed very strange to me, because the size of the sprue orifice is extremely important. It is, in effect, the gate that feeds the mold's internal melt-delivery system. And just like an actual gate, you don't want it to be too large or too small.

In several textbooks and material-supplier design guides, I read things like, "The diameter at the outlet of the orifice should be roughly 1 mm greater than the diameter of the connecting runner"; and "The outlet sprue diameter should be at least 1.5 mm larger than the wall thickness of the part being molded." I thought to myself—these are two of the dumbest things I've ever read. Never size a sprue based on how small or how big it will be where it meets the primary runner, or what the wall thickness of the part is.

Let's assume you had a 0.250-in. primary runner diameter. Using that first recommendation, the outlet diameter of the sprue bushing should be 0.250 in. + 0.039 in. (1.0 mm) = 0.289 in. Table 1 shows what the resulting orifice, or inlet diameter would be for the seven commercially available A-Series sprue-bushing lengths, which have the standard ½ in./ft, or 2.37° included internal taper. You can see that even the shortest sprue bushing is going to have a restrictive inlet for a ¼-in. diam. runner.

The second recommendation is even worse. Let's say the part has a uniform 0.100-in. wall thickness. Using this logic, the outlet diameter of the sprue bushing should be 0.159 in. Table 2 again shows what the resulting orifice or inlet diameter would be for

TABLE 1 Inlet Diameters for a 0.289 in. Outlet Diameter

A-Series Sprue Bushing Length, in.		Outlet Diam. = 0.289 in.
Fractional	**Decimal**	**Inlet Diam., in.**
1-13/16	1.8125	0.213
2-5/16	2.3125	0.193
2-13/16	2.8125	0.172
3-5/16	3.3125	0.151
3-13/16	3.8125	0.130
4-5/16	4.3125	0.109
4-13/16	4.8125	0.088

TABLE 2 Inlet Diameters for a 0.159 in. Outlet Diameter

A-Series Sprue Bushing Length, in.		Outlet Diam. = 0.159 In.
Fractional	**Decimal**	**Inlet Diam., in.**
1-13/16	1.8125	0.083
2-5/16	2.3125	0.063
2-13/16	2.8125	0.042
3-5/16	3.3125	0.021
3-13/16	3.8125	0.000
4-5/16	4.3125	-0.021
4-13/16	4.8125	-0.042

the seven commercially available A-Series sprue-bushing lengths, with the same standard internal taper. Not only is the short sprue bushing extremely restrictive, the longer sprue bushings are actually negative numbers!

It is my experience that more often than not, the sprue orifice is undersized. Many designers just don't know how to determine the proper sprue diameter. In fact, in a few cases, the undersized sprue froze off before the runner or the gate to the part did. That's why, when you do a gate-seal or gate-freeze study, you need to chart the weight vs. the hold time for both the parts and the runner separately. The weight of the runner must continue to increase after the weight of the parts stops increasing. If it doesn't, it means either the sprue or one of the runner branches is undersized and it froze off before the gate to the part did. You'll never be able to control your process if that happens.

There is another problem with having an undersized sprue-bushing orifice that is rarely, if ever, considered. If I told you that the amount of shear imparted to the material as it goes through a sprue bushing can be greater than the amount of shear as it goes through a gate, you would probably say, "How can that be possible when a gate is so small and a sprue-bushing orifice is so large?" In order to prove it to you, you need to know two formulas for calculating the apparent shear rate. The first formula is for round

TABLE 3 Flow Speeds of Various Sprue Orifice Diameters with an Inject Rate of 14.14 in.^{3}/sec

Sprue Orifice Diameter, in.		Shear Rate	Flow Speed Through Sprue
Fractional	Decimal	1/sec	mph
5/32	0.156	37,749	42
7/32	0.219	13,757	21
9/32	0.281	6473	13
11/32	0.344	3545	9

shapes, such as a sprue orifice or a conical subgate. The apparent shear rate is equal to $32Q \div (\pi \times D^3)$, where Q is the flow rate of the polymer and D is the diameter of the round orifice.

Using this formula, let's look at the shear rate and the flow speed of material going through different sprue-bushing orifice diameters. If you have a machine with a 3-in. diam. barrel and an injection velocity of 2 in./sec, the flow rate, or Q, coming out of the machine nozzle tip will be 14.14 in.^{3}/sec. Table 3 lists the shear rates and flow speeds for the four commercially available sprue-bushing orifice diameters for this 14.14 injection flow rate. Obviously, the smaller the orifice diameter, the faster the material is going to flow through it. The faster the material flows, the higher the shear rate. Note: Flow Speed (mph) = Flow Rate (in.^{3}/sec) ÷ Flow Area (in.^{2}) × 0.0568.

The second shear-rate formula is for rectangular shapes, such as an edge gate. The apparent shear rate is equal to 6Q ÷ (W×H^2), where Q is again the flow rate of the polymer, W is the gate width and H is the gate height. For the sake of example, let's assume the gate to a part is 0.070 in. deep × 0.150 in. wide.

TABLE 4 Flow Speeds Through a 0.070 in. × 0.150 in. Gate at an Inject Rate of 14.14 in.^{3}/sec

Number of Cavities	Shear Rate	Flow Speed
	1/sec	mph
1	115,405	76
2	57,703	38
4	28,851	19
8	14,426	10
16	7213	5
32	3606	2

TABLE 5 Flow Speeds Through a Conical Sub-Gate at an Inject Rate of 14.14 in.^{3}/sec

Number of Cavities	Shear Rate	Flow Speed
	1/sec	mph
1	93,157	76
2	46,578	38
4	23,289	19
8	11,645	10
16	5822	5
32	2911	2

Table 4 specifies the shear rate and the flow speed through each gate for molds with various cavitation—again using the injection rate of 14.14 in.^{3}/sec. As the number of cavities increases, the shear rate and flow speed decrease accordingly. When you compare Table 3 to Table 4, you can see that you may or may not have a problem, depending on the sprue-bushing orifice size and number of cavities. In this example, if you had a 7/32 in. sprue orifice it would have more shear than the gates in a 16- or 32-cavity mold for the given edge-gate size.

Since I'm the kind of guy that just can't leave well enough alone, I decided to check something out. I took the 0.070-in. deep × 0.150-in. wide edge gate in the previous example and calculated what the diameter would be for a conical subgate having the exact same flow area (0.070 in. × 0.150 in. = 0.0105 in.^{2}). The math works out to a 0.124-in.-diam. gate. I then used the shear-rate formula for round flow areas. The results are shown in Table 5, and they are what you might have expected. The round subgate had slightly less shear than the rectangular edge gate. That's because a round gate has a lower ratio of flow area to

TABLE 6 Standard-Length Sprue Bushing Outlet Diameters for a 0.315 in. Inlet Diameter

A-Series Sprue Bushing Length, in.		Inlet Diam. = 0.315 in.
Fractional	**Decimal**	**Outlet Diam., in.**
1-13/16	1.8125	0.391
2-5/16	2.3125	0.411
2-13/16	2.8125	0.432
3-5/16	3.3125	0.453
3-13/16	3.8125	0.474
4-5/16	4.3125	0.495
4-13/16	4.8125	0.516

perimeter length than a rectangular gate does. While edge gates are my preference, keep in mind that they will have slightly higher shear than a subgate with an equivalent flow area.

Getting back to how to determine the orifice size of a sprue bushing, use the same formula as we did when estimating the runner diameters in Part 3 of this series. For example, if the diameter of the primary runner was 0.250 in., then the sprue-bushing orifice would be the diameter of the primary runner multiplied by the number of runner branches to the ⅓ power (cube root). This works out to 58% more flow area than in the primary runner, which makes sense. If the calculated sprue-bushing orifice diameter is not a standard size, modify a standard bushing using a reamer or wire EDM. This also affords you the opportunity to change the included angle if desired.

Now let's look at the reality of the situation. A ¼-in.-diam. primary runner is fairly common, and the formula above for determining the sprue's orifice diameter is fairly accurate. Table 6 shows the resulting outlet diameters for the seven standard lengths of A-Series sprue bushings. Even the shorter lengths will form a thick mass of plastic at the parting line—considerably wider than the primary runner. The designer will assume this is a bad situation and reduce the orifice size of the sprue.

While having a large mass at the parting line is in fact an undesirable condition, reducing the sprue's orifice size is worse (see photo p. 30). The better decision would be to try to reduce the length of the sprue bushing, use a bushing made out of a copper alloy, increase the cooling around the bushing, reduce the bushing's internal taper, add gussets adjoining the sprue to the primary runner, or replace the cold sprue with a hot bushing. PT

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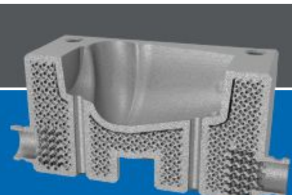

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By Jim Callari
Editorial Director

'Untapped Workforce' Helps Drive Growth at MDI

Minnesota-based firm extrudes corrugated HDPE sheet and fabricates it into all kinds of tubs, totes, boxes, and trays for businesses that include Fortune 500 companies. Its model is unique: a manufacturer in a competitive business-to-business environment that has a mission of providing employment opportunities for people with disabilities—in an integrated and inclusive setting.

There are a lot of numbers you can look at to tell the story of MDI, a Minneapolis-based company that extrudes corrugated sheet and converts it into tubs, totes, boxes and trays for the likes of the U.S. Postal Service and Fortune 500 firms in manufacturing, warehousing, distribution, logistics, e-commerce, and others.

Start with the number 1964. That is the year the company started as Minnesota Diversified Industries. Sister Anna Marie Meyers had 14 high school students with disabilities about to graduate without job opportunities. She founded The Occupational Training Center (OTC) as an extension program of Christ Child School

MDI fabricates totes, boxes and trays from corrugated HDPE sheet it makes in-house.

in St. Paul. Not long after, the OTC became independent of the school and named John DuRand as its executive director, thus beginning the first Minnesota-supported work program for people with disabilities. OTC evolved into MDI, which remains a not-for-profit business.

Remarks Barbara Majerus, MDI's v.p. of sales. "We believe people with disabilities have abilities, and they deserve opportunities to have meaningful work and become meaningful contributors to society." Majerus describes DuRand, who died in 2008, as the "catalyst behind the social and affirmative business enterprise model" who wrote books and gave speeches on the topic.

MDI runs two coextrusion lines for corrugated HDPE sheet in Grand Rapids, and is looking to add a third line for PP.

In that same report, Jeanne Eglinton, MDI's director of employment, notes, "Our mission is more than providing jobs, it's about creating an environment where employees can grow. Since 2017, more than 100 MDI participants have graduated from Career Skills, which teaches professional skills needed in today's workforce—including communication, leadership, work ethic, teamwork, and critical thinking. At the end of the program, graduates deliver their 'elevator speech' (a brief resumé) and share their goals for the future.

"Our goal is to help people with disabilities find meaningful employment and help employers see their strengths and talent. Career Skills is a true testament to the tenacity and dedication that exists in this untapped workforce," she adds.

There are other numbers too. The firm has four facilities in Minnesota: a 60,000 ft² plant at its Minneapolis headquarters; 83,000 ft² in Grand Rapids that houses MDI's two coextrusion lines, along with die-cutting and printing operations; a 36,000 ft² plant in Hibbing that makes wire frames used in many of its totes and boxes; and 110,000 ft² in Cohasset for design engineering, prototyping and other tasks.

Last year, MDI consumed 7.5 million lb of material, mostly HDPE, and had sales of about $30 million. It produced 2,681,755 plastic units in 2019. Both these numbers can vary significantly based on the Post Office's order volume. "Our sales vary based on USPS," says Rod Wood, MDI's COO. "In some years it's been as high as $49 million." The Post Office accounts for roughly half of MDI's sales.

But perhaps the most telling number on MDI's ledger is 46. That represents the percentage of its 388 employees (as of the end of 2019) with disabilities. "Our goal is to have 50% of our workforce with disabilities. Our contract with the USPS requires that 75% of the labor hours for the postal tote be performed by people with disabilities." All employees are paid at rates above the minimum wage, with benefits. Diane Meyer, the company's employee support supervisor, was quoted in MDI's 2019 Annual Report: "Our employees inspire and impress us every single day. They represent an untapped workforce in Minnesota and across the country. Jobs at MDI include support from on-site Employment Support Specialists. These jobs empower individuals to achieve greater self-sufficiency and personal fulfillment in an inclusive environment."

"We act like a for-profit company when it comes to manufacturing."

MDI also offers employees technical training at community colleges and brings in outside experts to train on safety, Kaizen, and lean manufacturing.

MDI is among 10 Twin Cities organizations that in 2019 formed the Unified Work Coalition (UWC) with the intent of advancing employment opportunities for people with disabilities. The group's long-term goals include creating a sustainable employment model, based on real-life working examples, that assists businesses who hire and support people with disabilities.

"We act like a for-profit company when it comes to manufacturing," says Majerus. "We expect everyone to meet or beat standards, work to their ability, be highly competitive, be highly productive and be highly efficient. And I would say that the vast majority of our workforce, while having a disability of some type, are highly functional."

IT STARTS WITH SHEET

MDI began by purchasing sheet from other processors, but in 1999 began processing its own sheet in Grand Rapids. Says Majerus, "The Post Office was the founding customer of MDI's plastics business." That 1999 extrusion line, purchased from HPM, is still running today, Wood says.

In 2005, MDI expanded its Grand Rapids facility and added a second extrusion system, this one from Welex, which Wood calls the "primary line," that runs on a 24/5 schedule. "We bring the HPM line on as needed, as this capacity was built primarily for the needs of the Post Office." Both lines have a 6-in. primary extruder and two 4-in. coextruders. MDI refeeds edge trim and die-cut scrap back into its process.

"We went with a corrugated sheet made mainly out of HDPE from the start because that is what the Post Office specified," Wood says. Sheet is typically made 4-mil thick and in widths to 53.5 in.

MDI is vertically integrated in corrugated HDPE tote manufacturing. Extruded sheet is die-cut, printed, folded and ultrasonic welded in house.

MDI follows specs for its sheet that originate in the cardboard industry; its typical sheet ranges from 0.16 lb/ft² to 0.3 lb/ft².

"We are one of the few companies in our markets that actually have a core business built around extruding polyethylene sheet," says Majerus. "Traditionally polyethylene has been more economical from a commodity-index perspective. Every now and then PP falls below that, but historically PE has been a more economical solution than PP. And there are certain applications in which the very nature of PE make it advantageous. For example, in very cold environments it does not become brittle. In our process, where we add a little bit of LLDPE to the HDPE, the totes work very well on conveyors because they have a little bit of a 'sticking power' to them."

PP boards, on the other hand, do not handle cold environments very well—they become very brittle and crack. But because there are applications where PP may be a better fit, MDI also furnishes PP-based crates and totes, buying sheet from outside vendors and die-cutting, folding, and ultrasonic welding it in-house. The company is looking at adding its own PP sheet extrusion line, so it will be vertically integrated in PP as it is in HDPE.

MINNESOTA DIVERSIFIED DIVERSIFIES

Some 11 years ago and true to its name, MDI launched a diversification strategy to enter the commercial business to help offset the volatility of its business with the Post Office. Recalls Majerus, who joined the company around that time, "We set up a robust reseller network around the U.S., and now are selling to many companies in manufacturing, warehousing, distribution centers, transportation/logistics, agricultural, sometimes medical related—any environment where goods are made, organized, or transported." Lots of those markets were still using cardboard, and MDI has grown that business to several million dollars a year, says Majerus. Last year alone, it got a $2.4 million order from Fortune 500 company in the warehousing/distribution industry that had been using cardboard.

Majerus notes that 95% of its commercial business is channeled through its reseller network. Having resellers across the country puts MDI in close geographic proximity to every major city in the U.S., but the company works hard to maintain direct contact with its end-use customers as well. "We are often in collaborative and joint meetings with our resellers and the final customers. The business ultimately goes through the reseller, but is supported throughout the sales process by MDI's sales-channel managers. We trust our resellers to do a great job representing our products—even though it's not always exclusive, and there are cases where the reseller has its own brand. Plus, we don't have the ability to create the infrastructure to get the kind of geographic and proximity coverage into all those accounts that we now have if we were to sell direct. We found a reseller model that has worked really well."

She adds, "Our level of service is a cut above everybody else, in terms of flexibility, responsiveness, lead times, and customer service. We wrap our arms around our customers. We treat them with 'TLC.' As a result, we have an extremely high retention and loyalty rate among both customers and resellers."

"We wrap our arms around customers. Treat them with TLC."

MDI does not have a one-size-fits-all approach to the commercial business, relying on its team of packaging design engineers to ensure the product line is customized for each application and its specific requirements. It has CNC machines to quickly turn prototypes around. And it has what Majerus calls "wide flexibility" in terms of order volume. She elaborates, "A lot of other extruders are not interested in working with you unless you have truckload quantities. But we have a niche of varying products, volumes, and custom solutions."

MDI took customization to the extreme in one recent commercial application. A new customer that MDI's reseller identified had been using cardboard in its warehousing operation and was experiencing outages as a result of the box breaking down on conveyors that ran as fast as 700 ft/min. MDI provided a PE tote, only to have the customer note that it made too much noise on the conveyor and was too light when only small or light parts were being transported.

Some 18 design iterations later, MDI had a final solution that involved redesigning the tote, adding hardboard to its bottom, and angling the flutes. This not only provided the sound-deadening the customer required, but the extra weight prevented the container from flying off the conveyor in instances where it was carrying light items. "We worked through varying solutions until we came up with the right product," says Majerus. "This has turned into a multi-million-dollar opportunity for MDI and has provided significant job opportunities for people both with and without disabilities." PT

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Five Big Advances to Track in Thin-Gauge Thermoforming

Fully-automated thermoforming system with robotic stacking and automated sleeving station.

High speeds, automation, smarter process control, integrated vision systems, and better decoration techniques are becoming more common among practitioners of the 'black art' of thermoforming.

By Conor Carlin
Illig North America

At last October's K 2019 show in Germany, an engineer from a large U.S.-based thermoformer asked why injection molding technology seemed to be so far ahead of thermoforming. While it is true that injection molded parts are produced at very high tolerances and thermoformed parts typically have some deviation, recent developments suggest thermoforming is not so far behind its injection cousins where technology advances are concerned. High speeds, automation, smarter process control, integrated vision systems, and better decoration techniques are becoming more common among practitioners of the "black art" of thermoforming. In fact, it might be time to retire that label.

This article highlights five areas of thin-gauge thermoforming where advances in technology are occurring at a fast pace, looking at the interplay of plastic materials, metal tooling, and production equipment. It is not meant to be comprehensive, and adoption is not uniform around the world. Like any specialized topic, the deeper you dig, the more details you find. There is a wide variety of applications in thermoforming that covers both heavy-gauge and thin-gauge processes.

AUTOMATION I: PART HANDLING

It is safe to say that when most thermoformers are asked about automation, they typically think of end-of-line solutions related to part removal. It is not, however, a one-size-fits-all answer. From simple A/B stacking mechanisms to robotic palletizing systems, there are a lot of ways for thermoformers to move parts. Perhaps the most common automation approach is to use a two-axis handling system where formed parts are clamped and broken from the web as part of the basic stacking system, then transferred via linear drives to a conveyor belt. The parameters for the stacking movements are set through a teach-in mode. Through optimization, speeds up to 40 cycles/min are possible with standard up-stacking motions. Other options include 180° or 90° rotations to create A/B stacks.

Automation means more than just parts handling. Consider inspection and quality control, as well.

Once parts are stacked, they can be moved to final packing stations, which can be as simple as automated sleeving systems or as complex as fully articulated robotic arms that place entire stacks into pre-erected boxes. Of course, these machines are typically not "core" to the thermoforming process itself, but the ability to integrate downstream equipment is key to delivering a holistic solution. Signal exchange from the main machine to the automation equipment is relatively simple. Gerhard Zdebor of Austria-based HOT&T Consulting explains the connectivity: "The downstream component receives a signal from the thermoforming machine when the stacks need to be moved. On the other side, the thermoforming machine receives a signal from the automation in case of any malfunction. Because of the high volumes, it is important to build in a safety or buffer zone when the automation is stopped so that the thermoforming machine can continue to produce."

The labor savings associated with automation are well-understood in many industries. The economics vary across countries, regions, and market segments. Labor costs are perhaps the biggest driver of investment, but low-value-added items can restrict a CFOs willingness to implement automation.

In-mold labeling for thermoforming offers high-quality decoration in a modular system, reducing costs and floorspace associated with downstream equipment.

AUTOMATION II: INSPECTION & QUALITY CONTROL

Automation is more than just parts handling. High-quality parts, or parts where high precision demands increased quality inspection and related costs, are manufactured on high-speed thermoforming lines with integrated cameras and rejection stations.

Up until recently, it was assumed that costs would outweigh the benefits of vision inspection systems in thermoforming. A true accounting of costs will include quality—e.g., reject rates, part failure, scrap rates. What is more difficult to measure, however, is reputational cost associated with bad lots. What is the cost of part failure on automated filling lines for baby food? Inspection systems provide greater awareness and visibility. That information, as a process-control tool, highlights where problems are. Reject rates most certainly increase initially, but the percentage of quality parts goes up over time. Identifying imperfections or flaws in parameters such as concentricity, flange thickness, and sidewall accuracy before parts are packed and shipped can substantially insure the bottom line. High-speed lines with up to 1400 cups/min can separate, convey, inspect, and restack parts.

IMPROVED PRODUCTIVITY: SOFTWARE & PROCESS CONTROL

At best, software is a productivity-enhancing tool. At worst, it creates additional work and frustration for users. Generally speaking, we have to adapt our behaviors when we adopt new software. Part of that K 2019 show conversation involved elements of process control, specifically a closed-loop system whereby changes in sheet temperature or plug-assist force lead to automatic adjustments in machine parameters. This can be categorized as *software that improves how the machine operates*, or making the machine more intelligent. Dynamic optimization of machine settings takes this a step further. After the operator enters the product data (part dimensions, material type and thickness), the machine can automatically calculate heating and forming parameters.

Creating networks between machines and manufacturing execution systems (MES) is a known best practice and is getting more attention under the rubric of Industry 4.0. With 1-ms control for input parameters now possible, exporting data to csv files can create a surfeit of data. Yet separating the signal from the noise is a critical first step in assessing data. The advent of "Big Data" means that we have a lot more information available, but not necessarily more time in which to analyze it. This has important implications for operators and staff, too, as training in data science becomes more relevant.

Demands from recyclers are driving increased adoption of packages where different materials can be easily separated.

Remote access or remote monitoring of equipment, recording and archiving of machine or tool settings, order management, and FDA- or GMP-compliant time-stamped data sets for audit purposes are some of the new functions and benefits of connected systems. These can be categorized as *software that improves the productivity of the user*.

Infrared scanning of sheet, either spot-based or line-based, has been used intermittently for at least 15 years, but with the arrival of improved data visualization tools, the technology is finding greater acceptance. There is, however, an alternative school of thought that calculates plug-assist or pre-stretcher power control—i.e., force required—with a central recording of the material's surface temperature across the entire sheet width. In order to keep process times constant, valve actions are monitored and, when necessary, the process parameters will automatically adjust to compensate for switching time.

The vast majority of machinery today runs on servo-driven platforms, primarily in chain indexing, press movements, and part-removal systems. A servo drive generates energy during braking since it works like a generator. Usually, this braking energy is discharged to the surroundings as heat. Feedback drive technology means the energy generated by the brakes flows into the intermediate circuit storage (battery). The drive controllers are connected to this circuit, allowing the energy to be used for a different servo drive.

MATERIALS MATTER: TOOLING TECHNOLOGY

Tool cost and turnaround time are often touted as key benefits of the thermoforming process, in both heavy- and thin-gauge sectors. It is still common practice for some thermoformers to manufacture their own tooling in-house. Before delving into actual tool technology, it is important to note that toolmakers have benefited from advances in CNC technology. Gone are the old manual lathes and Bridgeport presses.

American, German, and Japanese equipment dominate the machine-tool sector. Lights-out automation allows greater flexibility in scheduling and reduces the need for operator oversight. Surface finishing has been improved, adding further time and labor savings for tool shops. From the extrusion sector, changes in CPET and CPLA material formulations have led to new tools that eschew oil-heated dual-stage molds in favor of electrically heated single-stage molds.

Major developments in tooling technology can be categorized as follows: choice of materials, air flow, and water flow.

The increased use and acceptance of aluminum has helped to boost speeds through better temperature management and weight reduction, leading to faster machine movements. Cooling is up to 7x faster with aluminum tools. The use of closed water systems with minimum seals, corrosion-resistant materials, and optimized water pressure enables a wide temperature window with reduced condensation, a "no-sweat" effect. With trim-in-place tooling in particular, independent clamp-ring pressure and individual downholder cooling allow highly precise and repeatable parts.

Tim Douglas, scientific technician at PinnPack Packaging, Oxnard, Calif., sees important benefits in experimenting with tool coatings. "From simple hard anodizing to PTFE coatings that allow release of undercuts for stripping, coatings help to increase tool life and prevent wear," he says. "Some of the higher-end coatings from Endura Coatings or Sun Coating Co. add material-specific protection. When running CPET, for example, there are coatings for the plugs and the cavities for better release and reduced friction." All of these are FDA-, NSF- and USDA-safe.

QUESTIONS ABOUT THERMOFORMING?
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Improved air-flow management, including air-save technology for faster filling and venting, and locating valves closer to the cavities, also help to increase production speeds. Tools can be outfitted with sensors to monitor strain, pressure, temperature. The newest tools from Germany are now being equipped with user-friendly NFC or RFID tags for full life-cycle documentation, alerting operators to maintenance requirements.

The advent of Big Data means that we have a lot more information available, but not necessarily more time in which to analyze it.

INTEGRATED DECORATION

The use of pre-printed sheet in thermoforming has been mastered for at least 25 years. A-B and A-B-A configurations, hinged clamshells, and candy striping can be run on most equipment today. Distortion printing can be effectively modeled in computer simulation tools such as T-Sim before going into production, where little more than sensor eyes are required to detect specific areas of the sheet. Secondary processes such as labeling, dry-offset printing, and digital printing offer high speeds, but they represent additional capital spending while increasing the system's footprint.

A key attribute of thermoforming is the ability to use materials to form parts with 100% barrier protection, usually in a structure like PP/EVOH/PP. Adding decoration to barrier films creates new avenues for part designers and product marketers, especially in mass-customization environments like supermarkets or specialty food stores. In-mold labeling for thermoforming (IML-T) offers considerable weight-reduction opportunities versus molded parts. Because the label is integrated into the forming process, IML-T reduces capital expenditures and floorspace, while providing a wider range of graphic options associated with label printing. And because the material is not preprinted, there is no gas emission from print colors during heating, and the skeletal sheet can be easily granulated for reuse without contamination.

The latest developments in IML-T now include the ability to make labels from polymer substrate, paper, or even cardboard. Recycling concerns—especially sortation—are driving the need for packages that can be easily separated when using two or more materials. PT

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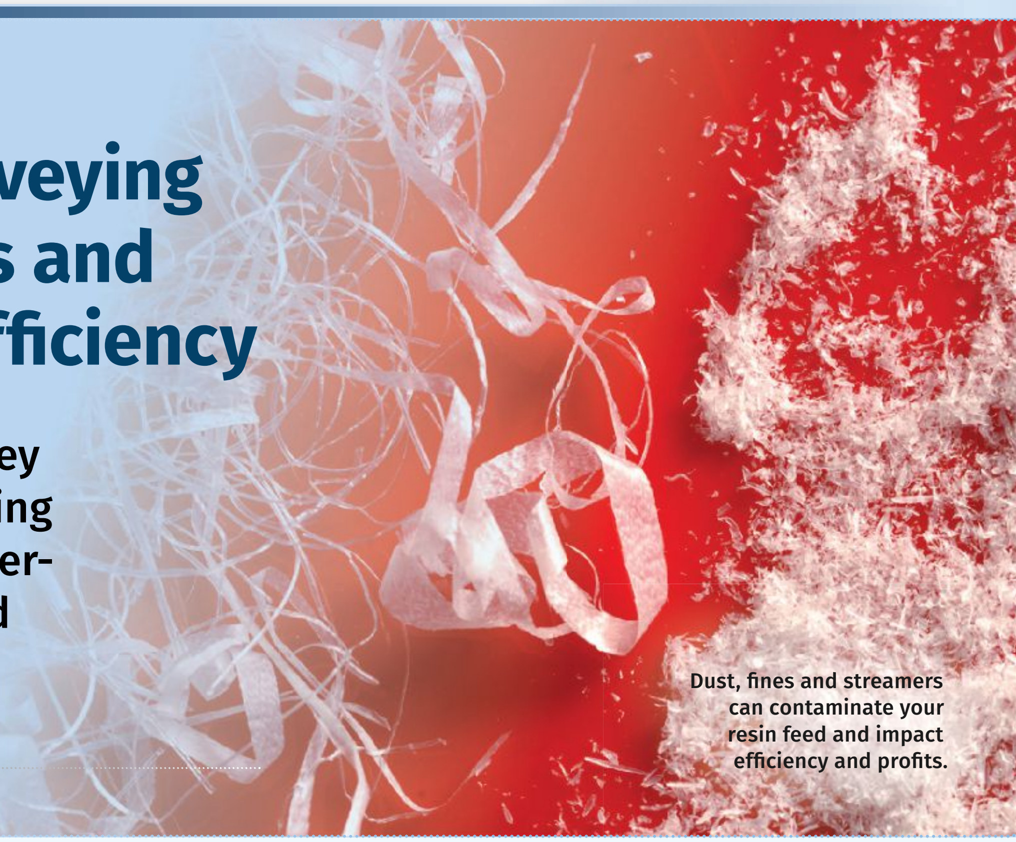
Clean Conveying Cuts Costs and Enables Efficiency

Focus on three key areas when moving material for better-quality parts and less downtime.



Dust, fines and streamers can contaminate your resin feed and impact efficiency and profits.

By Joseph Lutz
Pelletron

All plastics processing starts with moving resin to the machine, and while it can be easy to overlook the first step in any multi-step activity, processors would be remiss to downplay the vital role conveying plays in establishing a robust operation. From the silo or the gaylord to the mold or the die, there are three key areas processors need to think about when they start moving material. The design and operation of your conveying system, the choice of elbows for that system, and accounting for fines and streamers will get your conveying on the right track.

NUMBER 1: POOR CONVEYING COSTS YOU MONEY

Selecting the right pneumatic conveying system is important for economic and reliable operation of your processing plant. Poorly designed conveying systems cause plant-wide inefficiencies like high scrap rate, high maintenance costs, and housekeeping problems, to name a few.

Part of the problem is that just about anyone can design a pneumatic transfer system to move pellets from Point A to Point B. Use enough air and you can transfer a car through a pipe. Only experienced designers, however, can design an *efficient* transfer. Many parameters have to be considered in the system design, and while there are some standard formulas to follow, some decisions are made simply based on experience.

> *It takes specific process design experience to keep your velocity low, but not too low.*

- **Optimize your pipe route:** Dust and streamers are formed when relatively soft pellets impact the rigid pipe wall. A shorter, more direct route with fewer bends reduces the amount of dust and streamers that are generated during conveying.

- **Fix your conveying pipe:** Misaligned pipe flanges and couplings are a common cause of dust generation. The step created by pipes that are not concentric is the perfect opportunity for soft plastic to be degraded. Take care when installing compression couplings or use more sophisticated self-aligning flange designs.

- **Reduce your conveying temperature:** It's not always possible to reduce the temperature of the solids that you're transferring but do it if you can. More dust and streamers are generated at higher temperatures. Consider using heat exchangers on positive-pressure transfer systems to lower the conveying-air temperature since positive-displacement blowers and compressors add heat to the transfer system.

QUESTIONS ABOUT CONVEYING?
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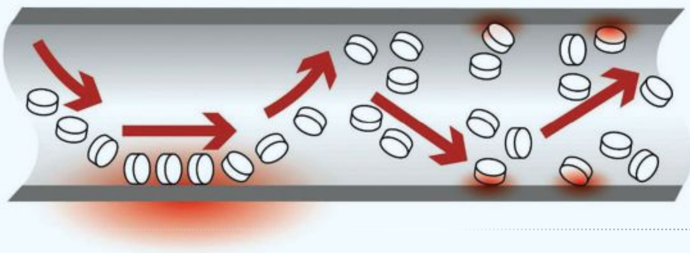
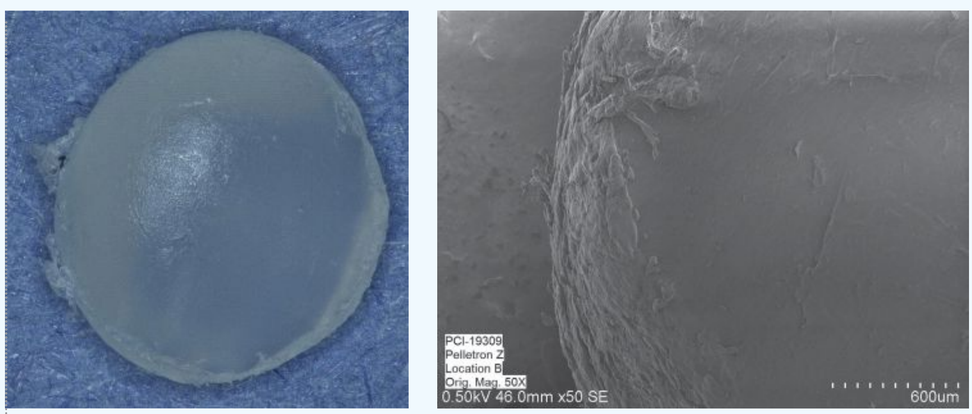


Pellets impacting the pipe wall leave patches of plastic on the inside surface of the pipe. These patches melt together due to friction, which creates a coating on the pipe. This coating eventually tears off in strips.

- **Reduce your conveying velocity:** High conveying velocity is the most common cause of dust and streamers. Simply put: Higher velocities create more fines and streamers. Keep your velocity lower than 5000 ft/min.

- **Watch for patches:** Pellets impacting the pipe wall leave patches of plastic on the inside surface of the pipe. These patches melt together due to friction, which creates a coating on the pipe. This coating eventually tears off in strips.

Sounds easy? In fact, it takes specific process-design experience to keep your velocity low, but not too low. If you don't have enough velocity on the runway, then the plane doesn't get off the ground. To avoid a conveying catastrophe, an experienced pneumatic-conveying process designer selects the right velocities for your system. The process designer will even have a few tricks for maintaining low velocity throughout the system, like using stepped pipe sizes and high product-to-air ratios. If your process designer can't tell you what the product-to-air ratio is for your system or what the velocities throughout the system are—start and finish—then look elsewhere.



A 100X magnification by scanning electron microscope (right) shows surface damage on a pellet (left) caused by impact with a rigid pipe wall from a typical pneumatic conveying process.

- **Run at full capacity:** It is a common mistake to reduce the solids transfer rate so the system is not running "too hard" or to lower the transfer rate to match a downstream consumption rate. As mentioned earlier, fines and streamers are generated when pellets impact the inside of the transfer pipe wall. These impacts happen more often and at higher speeds when a conveying process is too dilute. Adjust your vacuum pickup box or rotary valve to feed the most solids possible into the transfer pipe while maintaining a stable conveying pressure.

NUMBER 2: THE WRONG PIPE ELBOWS COST YOU MONEY

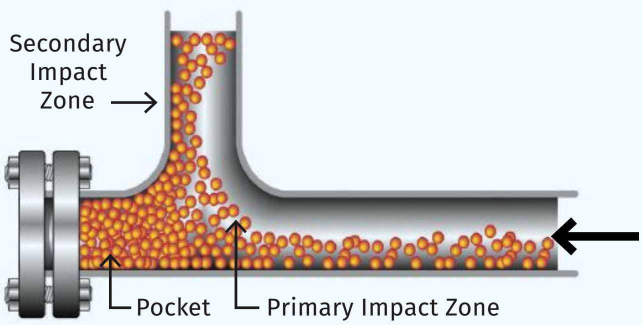
A significant amount of fines and streamer generation occurs in the bends—specifically, in traditional long-radius elbows. Pellets slide along the elbow wall and change direction in the pipe at high velocity. Centrifugal force then presses the pellets against the wall of the pipe. The friction of this interaction creates heat, which melts the outer layer of the pellets, resulting in a thin film buildup along the surface of the wall. This buildup eventually breaks loose, forming unwanted streamers and fluff that lead to product contamination. Abrasive materials, such as glass-filled pellets, wear out the elbow walls quickly due to these high frictional forces.

Various types of alternative pipe bends, or specialty bends, are available on the market to solve these problems in positive- and negative-pressure, dilute-phase pneumatic-conveying systems. Each type of specialty bend has its own positive and negative attributes.

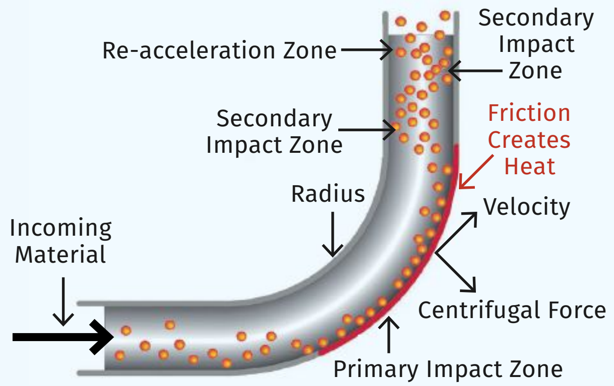
- **Pressure drop:** All specialty bends increase pressure drop compared with a long-radius bend. Increased pressure drop can cause a reduction in transfer rate, so make sure you consult your process designer or discuss the topic with your specialty elbow supplier before you pull the trigger.

- **Use them for the whole line:** One common mistake when applying specialty elbows is to replace only one bend at a time. While this might work for solving wear in a particular elbow that breaks down most often, fines and streamer generation is a function of all of the elbows. Changing one will probably not have a significant impact. If you can't get budget approval for replacing all your elbows, then at least start with replacing the elbows at the end of your transfer line. That is where the pressure is lowest, and consequentially, the velocity is the highest.

- **Choose the right type.** The standard Blind-T elbow has been around the longest. It has a short radius and a pocket that fills ►



Blind-T specialty elbows have a short radius and a pocket that fills up with pellets to act as a cushion for the incoming pellets that are changing direction.



Pellets sliding along the outside of the bend cause fines and streamer generation.

up with pellets to act as a cushion for the incoming pellets that are changing direction. This is typically the most cost-effective solution, but the pressure drop can be the highest of all specialty bends, and contamination can be a problem since the pocket does not self-clean. There is also a secondary impact zone after the pocket that can be problematic too.

Other specialty elbows have been developed over the years to improve on the old Blind-T. They usually have less pressure drop than a Blind-T, but more pressure drop than a long-radius bend; so again, consult your process designer or supplier for guidance. The benefit of these designs is that they redirect the pellets without creating streamers or fines and they usually clean out completely by just running the transfer air with no pellets fed into the system. They also significantly reduce wear in the elbows. Some are even quieter than regular long-radius bends.

NUMBER 3: FINES AND STREAMERS COST YOU MONEY

Unfortunately, you can do everything right and still end up with a dust and streamer problem. Even the best pneumatic-conveying system design with the best specialty bends will damage pellets. Minimizing the amount of conveying that you do in your plant can significantly reduce the amount of attrition that you create, but it still won't be zero. And besides, how clean is the material that you receive from your supplier? Contamination could be surprisingly high, and you usually have very little control over that.

The good news is that you can take control of the dust and streamer content in your material by adding a dust-removal system. These are not dust-collection systems that just filter air before releasing it to the atmosphere. Active dust-removal systems are a "treatment step" in your process where the fines and streamers are separated from your pellets. They can be as simple as angel-hair traps or as complicated as drum sieves.

How clean is clean? The basic categories are fine dust (0-500 micron particle size), coarse dust (>500 micron particle size) and streamers that can be as small as a fingernail or longer than 2 m (6.5 ft). The "arm-hair test"—how much dust sticks to your arm hairs when you reach into a sample—is sometimes good enough for spotting coarse dust and streamers, but you really need a standard test method to quantify cleaning performance. The ASTM D1921 dry-sieve standard is typically used for coarse dust and streamers. The ASTM D7486 or FEM 2482 standards are used for fine dust.

Choose the right dust-removal system. Angel-hair traps are simple and economical, but they can clog quickly; they require frequent maintenance; and they don't capture all streamers. Look for dust-removal systems that don't require frequent maintenance and use counterflow air to wash dust and streamers off the pellets.

Elutriators, zig-zag sifters and dedusters all operate with this same general counterflow principle. Elutriators can only be installed in your conveying system and can be very tall. They also don't separate streamers that well and can only be positioned on top of silos, which means residual dust can accumulate below them. Zig-zag separators are very effective for removing labels but they often cannot effectively remove fine dust very efficiently. They are generally tall and also require a lot of air. There are deduster systems on the market that are shorter in height and use an electromagnetic coil on the inlet to achieve higher separation efficiency with fine dust as well as coarse dust and streamers. These deduster systems and zig-zag separators operate with gravity flow, so they can be positioned right before the point of use (packaging, extrusion, injection molding, etc.).

Follow good conveying-system design practices and use the latest technology to improve scrap rate, reduce maintenance and reduce housekeeping costs. Most processors don't have an in-house material-handling guru, so don't hesitate to get help from your equipment supplier.

ABOUT THE AUTHOR: **Joseph Lutz** is the dir. of sales & marketing for Pelletron Corp. He has over a decade of technical experience developing bulk material-handling solutions for the plastics industry. His career at Pelletron began in R&D, where he learned the ins and outs of pneumatic conveying in the test lab. Lutz has also has commissioned numerous pneumatic-conveying systems all over the world and earned three patents for new products. Contact: *717-381-3437; joseph.lutz@pelletroncorp.com; pelletroncorp.com.*

How to Properly Maintain Aluminum Injection Molds

Aluminum and steel tools have some important differences, but also one key similarity: Routine maintenance will extend the mold's life and boost the quality of its output.

This aluminum mold has produced close to 200,000 shots of ABS in four cavities, with a logo removal and hard-coat stripping and reapplication midstream.

By Scott Lammon
Phoenix Proto Technologies

With proper care and maintenance, aluminum tooling can reach the million shot mark and beyond, as found by Honda's multi-year study and by others. There is not one set of guidelines to follow for aluminum tooling maintenance, but rather each aluminum tool needs a maintenance plan that is customized for that specific tool.

There are several factors in determining a maintenance plan for aluminum tooling. Type of resin to be molded, any mechanical actions in the tool, gate type, and whether a coating has been added are just some of the factors to consider when determining a maintenance schedule.

DESIGN IN POTENTIAL PART CHANGES

Whenever possible, during the design phase of a mold, it is beneficial to know of any potential part revision areas that might occur down the road. If any such areas are known upfront, the mold can be designed with an insert in the area that could potentially change. Doing this upfront may slightly increase the original tooling price but will be more cost-effective when a revision is needed later on. This is not to say that inserting cannot happen later, because it can and does happen quite often. However, there are occasions where after-the-fact inserting would sacrifice the integrity of the tool and therefore would require a complete rebuild.

QUESTIONS ABOUT ALUMINIUM MOLDS?
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Inserting an aluminum mold is the preferred option vs. welding, because the latter can leave a pitting effect, and the weld will be softer than the rest of the mold. For best results in welding aluminum, the welding rod must be equivalent to the aluminum of the tool. Proper prepping is also required to avoid welding issues. Inserting high-wear areas, such as slide-by shutoffs with minimal draft or the gate area when using highly abrasive resins, is also a good practice to consider with aluminum tooling.

RESIN'S IMPACT ON TOOL LIFE EXPECTANCY

Several material-related precautions need to be addressed to extend the life expectancy of an aluminum injection mold. Filled resins will tend to wear out the shutoffs and the gate area, but one of the precautions that can forestall that wear is a Nibore coating. Adding a Nibore surface coating of about 0.0002-0.0003 in. to an aluminum tool raises the surface hardness up to 50-56 HRC. This process can usually be done in about three days and can always be stripped and re-applied if the coating starts to show wear. The coating is also good at reducing the amount of oxidation that occurs in an aluminum mold, and it acts as a release agent when ejecting the part off the tool.

If a coated aluminum tool needs another coating or a part revision is required, the coating can be removed, machined or welded. In the image above, you will see the customer requested a logo removal. The tool was machined to remove the hard coating, then welded and polished. The next step involves stripping and adding another hard-coat application if it would be required for cosmetic reasons. In this case, the parts were acceptable without re-coating. To date, this mold has produced close to 200,000 shots in four cavities using ABS resin.

Thanks to its thermal advantages, an aluminum mold's process window is typically larger than steel's, but processors should beware of excessive temperatures and pressures.

Just like their steel counterparts, aluminum tools should be taken apart and cleaned thoroughly after a part run and prior to storage.

If possible, mechanical actions are preferred over a manual operation for a few reasons. Cycle times will be faster and more consistent, which results in a shorter residence time in the barrel. Often, a manual action will also require a pull-fixture to properly remove the hand load from the molded part to prevent part distortion. Any time a hand load is used, the chance of an operator placing it carefully back in the tool the exact way every shot is highly unlikely. Not to mention the fact that there is the possibility of the hand-load getting damaged when handled outside of the mold, as workers rush to keep the cycle time as low as possible. In addition, for maintenance reasons, mechanical actions are better options than hand loads since they usually require less preventive maintenance and repair, because the hand loads can potentially be mishandled during the cycle.

PROCESS PARAMETERS AFFECT ALUMINUM TOOL MAINTENANCE

What happens while an aluminum mold is in the press can in some ways be just as important as what happens when the tool is on the bench for routine maintenance. Molding practices are different when comparing an aluminum mold to a steel mold and should be implemented as such. Excessive temperatures and injection pressures can damage a tool rather quickly and eliminate any possibility of a long life expectancy. Whether it is detail shifting under high injection pressures, or galling from extreme temperatures, the integrity of the tool can be reduced rapidly. Normally the process window for aluminum is greater versus a steel mold due to its improved thermal advantages.

> ***With experience and strong procedures in place, an aluminum mold can produce 1 million shots-plus on many occasions and with multiple resins.***

A ROUTINE MAINTENANCE ROUTINE

Aluminum molds should be taken apart and cleaned thoroughly after every run of parts. The frequency with which this should happen is largely dependent on the resin that is used to mold the product and whether there are actions in the tool. Often, an aluminum injection mold can run five to seven days before needing to be cleaned, but other cases may require a cleaning after two to three days, for various reasons. Regardless of how short the run is, aluminum molds should be cleaned once they're removed from the press and prior to storage ahead of the next order of parts. Checking for wear and/or galling should also be part of the routine maintenance that is done every time a mold is removed from the press.

Whether your molds are built from steel or aluminum, all preventive-maintenance practices are vital. With experience and strong procedures in place, an aluminum mold can produce 1 million shots-plus on many occasions and with multiple resins. It is important to note that routine maintenance also promotes optimal performance and high-quality parts. Considering that, and aluminum's thermal advantages, the material is a strong choice for many molds produced today. PT

ABOUT THE AUTHOR: Scott Lammon is v.p of tooling at Phoenix Proto Technologies, Centreville, Mich. He has been with the company and in the moldmaking and plastics industry for more than 25 years and was a designer/programmer prior to assuming his current position. Contact: *269-467-8300; scott.lammon@phoenixproto.com; phoenixproto.com.*

INJECTION MOLDING

High-Speed Electric Line Comes to North America

Originally launched in 2016, Haitian's Zeres electric-machine line was expanded with the F series at K 2019. Now available in the U.S. and Canada, Zeres F machines target molders interested in entering the high-speed market that may not have the production volumes or cycle-time requirements to justify the cost of traditional high-speed machines. Zeres F machines achieve injection speeds up to 350 mm/sec with an economical price tag.

While the main drives of the Zeres are electric, the machine also has an integrated hydraulic system to handle cores, ejectors, optional valve gates and injection carriage movement.

The Zeres F is available from 169 to 506 U.S. tons and features an abrasion-resistant screw and barrel with 25:1 L/D. The injection unit rides on linear rails, and the injection carriage is double cylindered with programmable nozzle contact force. There are also linear rails for clamp movement, with the ability to support heavy stack molds.

INJECTION MOLDING

Better Flow Simulation with Fiber Reinforcements

CoreTech System Co., supplier of Moldex3D flow-simulation software, says it has increased the accuracy of injection molding and compression molding simulation with long- and short-fiber reinforced thermoplastics. The problem, according to CoreTech, is that flow-induced orientation of the fibers causes anisotropic flow of the melt in the mold. "So far, simulating such a fiber-orientation-induced anisotropic flow has still been a challenge for state-of-the-art CFD (computational fluid dynamics) software," says Dr. Huan-Chang (Ivor) Tseng, R&D program manager at CoreTech.

This anistropic flow can be observed by placing a circular "hocky puck" charge of glass-mat thermoplastic (GMT) sheet in a compression mold (Fig. 1). The circular disk deforms into an elliptical shape as it flows. In injection molding, unreinforced plastics typically show a smooth, continuous flow front (Fig. 2, top); but Dr. Tseng says, "Some peculiar, irregular filling patterns are known to occur for high concentrations of short or long fibers" (Fig. 2, bottom). These patterns show the flow front advancing faster along the sidewalls of the cavity than in the center.

CoreTech says it has overcome this challenge by incorporating the informed-isotropic (IISO) viscosity model developed by Dr. Anthony J. Favaloro and Prof. R. Byron Pipes at the Composites Manufacturing and Simulation Center of Purdue Univ. The details of the IISO model recently were disclosed in U.S. patents and published in scientific journals.

Using this model, CoreTech's Moldex3D simulated compression molding of PP with 25% long glass in a unidirectional orientation. The simulation correctly predicted an ellipse developing from the original circular charge. For 50% short glass in nylon 66, Moldex3D predicted an injection molding flow front advancing faster along the side walls than in the center.

The new "fiber coupling" function is incorporated in the current Moldex3D R17 version and in the new Moldex3D 2020 version, which adds the ability to see how changing the fiber length and concentration will affect the filling pattern.

FIG 1 Compression Molding a GMT Disk

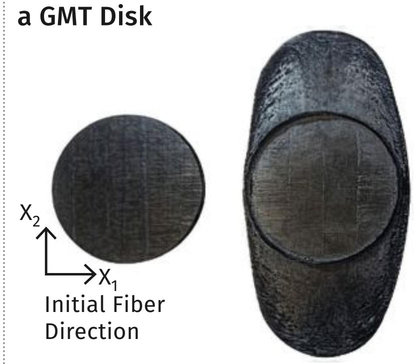
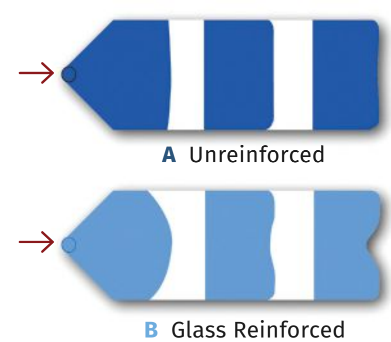


FIG 2 Injection Molding Thermoplastics



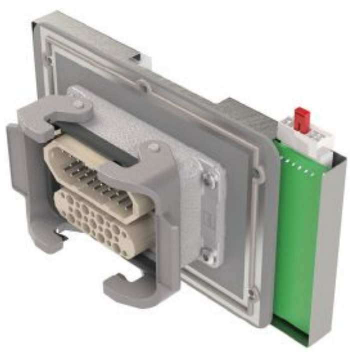
INJECTION MOLDING

Automation: Cobot Adds Interface for Easier Integration with Injection Machines

In response to increased growth in the market, Universal Robots (UR) has developed an Injection Molding Machine Interface (IMMI) to make communication between its e-Series cobots and molding machines fast and easy.

UR expects that 15% of all cobot applications in 2020 will be in injection molding, automating tasks such as placing inserts into molds and moving parts through post-mold processes.

Compatible with EUROMAP 67 and SPI AN-146 communication interfaces, the new IMMI eliminates the need for a hardwired connection with discrete IOs and the development of custom application software to map those IO points coming to and from the injection molding machine. Newer (made in 2020) e-Series robots using the IMMI can now simply plug in and use a standard interface to communicate.

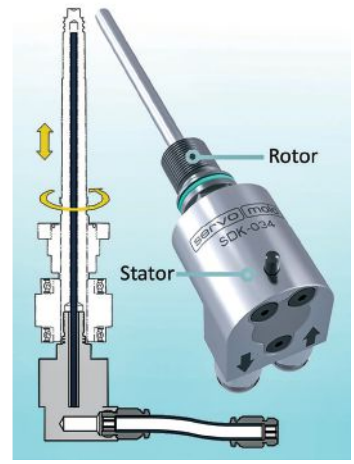


With the IMMI, UR says molders have the ability to set up, program and control the entire application cycle through the cobot's teach pendant. The company says the IMMI can be installed in the UR cobots' control box in less than 10 min. The IMMI is currently available through UR's UR+ platform of products certified to work with UR cobots.

TOOLING

Rotary Cooling Device for Rotating Cores

i-mold in Germany says its compact, standardized unit consists of a twist-lock-installed stator with coolant-hose connectors and a rotor, which supports the cooling pipe and the thread to attach the rotating core. i-mold says this technology reduces the time and cost associated with a custom rotating core, as well as eliminating potential cooling-water leaks, since each unit is leak-tested and warrantied leakproof by i-mold.



In multi-cavity molds, i-mold says processors can connect up to four rotary cooling units in series. Additional groups of four can then be arranged in parallel, creating compact molds with a large number of rotating cores.

Offered in two sizes, the rotary cooling units are suitable for all common mechanical, hydraulic or servoelectric rotating core drives. Standard plug-in couplings connect the coolant hoses, with quick-acting couplings optional.

TOOLING

Heat-Resistant 3D Printing Material Suited to Plastic Tooling

A tough, heat-resistant resin for 3D printing was introduced last November by 3D Systems. It was touted for its strength, rigidity and especially its "best-in-class" heat-deflection temperature around 90 C (194 F), as well as its biocompatibility (meeting USP Class VI 93 standards) and ability to reproduce ultra-sharp details. Now, the company is promoting this VisiJet M2S-HT90 as "the first in a new line of advanced specialty materials for indirect manufacturing"—including jigs, fixtures and plastic tooling inserts for processes such as thermoforming and injection molding. According to the company, small mold inserts can be produced in a few hours for around $100 or less.

Suited for the MultiJet 3D printing process (analogous to inkjet printing), this acrylic-based resin is cured by UV light and needs no postcure. It cures to "water-clear" transparency.

For thermoforming tool inserts, M2S-HT90 can be deposited with an easily removable wax support to produce a porous lattice structure and built-in vacuum holes (no need for drilling). In thermoforming trials, shallow-draw parts were formed on these inserts with no noticeable degradation after 100 cycles.

In injection molding trials, PP parts were molded using 3D printed tool inserts at 176 C (349 F) with 250 psi barrel pressure and 1800 psi core pressure. Ten to 15 parts were printed successfully. 3D Systems says M2S-HT90 can withstand molding of resins such as PP, PC, ABS, PVC and PMMA (acrylic) at 140-200 C (284-392 F), and the inserts are resilient enough to be bolted to the mold base (ultimate elongation is 4-9%).

Other potential applications include tools for RTV silicone molding and for sheet-metal forming at up to 15 tons of force (withstanding 100 cycles in testing).

EXTRUSION

Energy-Efficient Dryer for Complex Profiles

The Profile Dryer from U.K.'s Air Controlled Industries (ACI) is a compact and efficient system designed to draw out moisture from unusually shaped profiles. The dryer uses vacuum rather than compressed air to remove water without damaging or distorting the extrudate. In addition to achieving high drying efficiency, ACI's profile dryer reportedly offers major cost savings through lower energy consumption—utilizing a 1.5- or 3-kW motor—and the ability to capture and recycle coolant on the extruded product.

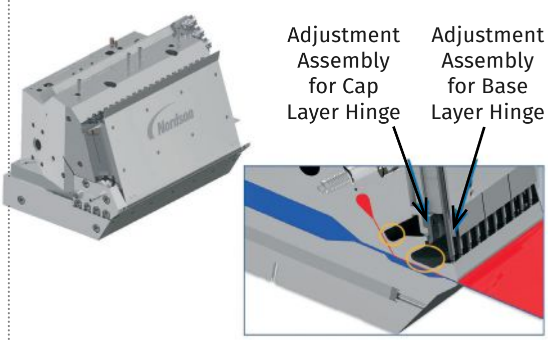
The unit is fully enclosed and about 4 ft long. The main enclosure contains a side-channel blower and cooling fan as well as a water separator, which collects coolant for recycling. The unit is stainless steel with ceramic rollers. The drying head can be configured to individual specifications.

Designed for intricate profiles, the Profile Dryer can dry extrusions up to 65-mm in diam. Drying speed varies with profile size, but smaller profiles of up to 6 mm reportedly can achieve a drying speed of up to 328 ft/min.

EXTRUSION

Flex-Lip Die Cuts Resin Use in Capstock Layers

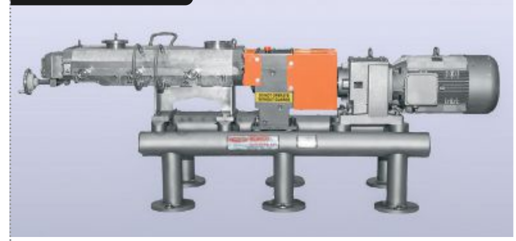
A new, patented device for multi-manifold dies controls the layer thickness of costly capstock polymers, enabling processors of vinyl siding, glazing, hot-tub panels, refrigerator parts, and other sheet products to reduce material costs. Incorporated in a new EDI Ultraflex multi-manifold sheet die from Nordson Corp., the device consists of a flexible hinge that for the first time makes possible fine-tuning of the capstock layer. Located in the flow channel for the capstock polymer at a point before it combines with the base polymer, the hinge can be adjusted to provide uniform, streamlined flow necessary for a consistently effective cap layer. At the same time, a conventional flexible lip located downstream can be adjusted to ensure a consistent gauge for the overall two-layer structure. This is said to reduce scrap rates and eliminate the need to run unnecessarily thick cap layers to compensate for thickness variations.



In production runs by a vinyl siding manufacturer, the new dual flex-lip die made possible an 11% reduction in consumption of ASA, widely used for UV protection in vinyl siding. This represented an annual saving of $55,669. Because the overall thickness of the siding was unchanged, the amount of ASA saved was replaced by much less expensive rigid PVC. And since the new die necessarily included a flow-channel design that was more advanced than that of the old die that it replaced, the total annual savings was actually double the $55,669 amount.

While currently offering the new technology for vinyl siding, Nordson anticipates that it will also provide cost savings in other sheet products that require cap layers. One example is UV layers for transparent polycarbonate sheet used in specialty windows, stadium glazing, and greenhouses. Another is gloss layers for hot-tub and refrigerator panels.

COMPOUNDING



Continuous Processor Can Run Safely on Empty

Continuous Processors from Readco Kurimoto feature a proprietary power-transmission design and bearing configuration that allow them to operate safely while running on empty. Said to be an improvement on extruders that must rely on the polymer melt to guard against metal-to-metal contact with the barrel, the Readco units automatically prevent the mixing elements from contacting the barrel, eliminating risk of contamination from metal particles and allowing safe startup without any material present. By loading the recipe, raising the barrel temperature, and verifying the system settings while running empty, the Continuous Processor reportedly saves on both material and energy at every startup.

When shutting down for cleaning or maintenance, the units can allow their self-wiping action to automatically purge approximately 95% of the material from the mixing chamber. This minimizes the need for chemical cleaning agents, offering especially significant cost savings and environmental protection in systems requiring solvents for cleaning.

COMPOUNDING

Higher-Performing Pilot Machine

The P 2.0 series single-screw compounder from Collin has an output capacity 25% above previous models and can operate at speeds of 1200 rpm with a torque rating of 13 Nm/cm^3, allowing it to process highly viscous or highly filled materials. The series is available with processing lengths from 36:1 to 60:1 L/D. Multiple side feeders with gravimetric or volumetric dosing can be added.

Designed for pilot production, the series features a height-adjustable and space-saving design, allowing it to be used as a coextruder in blown film and other applications. The screw can easily be pulled backwards out of the machine for cleaning without having to move the machine.

Collin's CMI 17 control comes as an option. Interchangeable cylinder elements with coded plugs can be arranged in nearly any order, since the control recognizes the respective function via the coding.

COMPOUNDING

Closed-Loop System for Coex Film Reclaim

Coperion has developed a closed-loop system for recycling post-industrial multi-layer film, a recovery process that historically has been challenging and complicated. The recycling system consists of bulk material-handling equipment, a Coperion K-Tron feeding system and Coperion's ZSK Mc^{18} twin-screw extruder.

In the Coperion setup, multi-layer production scrap would first be shredded, then fed into the ZSK extruder via pneumatic conveying and precise feeding from Coperion K-Tron. In the corotating ZSK Mc^{18} twin-screw, material is homogenized and devolatilized. Coperion says the extruder is designed to "gently" and thoroughly mix the material even at very high throughput rates. Following homogenization, the recycled material is added back into the production process at rates up to 100%.

MIXING

Inline Rotor/Stator Homogenizers Can Be Moved About

A mobile skid on Ross' inline high-shear mixers allows them to be used anywhere in a plant, saving time and money by eliminating the need for multiple mixers separately dedicated to each vessel or product. The mixers are available from 1 through 250 hp, and accelerate mixing, emulsification and homogenization in both recirculation and continuous modes.

The pictured Ross Model HSM-410 Inline High Shear Mixer can handle applications with viscosities up to 20,000 cp. A VFD or control panel may be mounted to the cart and wired to the mixer motor for complete portability.

Image above (screws) courtesy of Davis-Standard

INDUSTRY 4.0

Wittmann Battenfeld Makes OPC UA Connectivity Standard

Wittmann Battenfeld is now making OPC UA connectivity standard on all Wittmann 4.0 compatible machinery ordered from April 1 onwards. This will allow that equipment to communicate freely with the company's injection molding machines that feature the B8 control system. The OPC UA communication protocol is fast becoming the standard for Industry 4.0 "smart factory" networking.

With this connection, all functions of these auxiliaries can be manipulated centrally on the Wittmann injection machine's B8 control unit, applying their familiar menu structure. Wittmann says this extends the mold data set to include not only the usual process parameter settings for the machine itself, but to also contain the Wittmann 4.0 auxiliary and Wittmann R9 robot settings. With that, the total required set of production equipment to support a given mold can be retrieved at any time from the mold catalog of the B8 control. Using this, an operator can quickly prepare a machine for a mold change, pulling up the required auxiliaries—and their settings—automatically.

Following that mold change and the mechanical and electrical connection of the auxiliaries to the mold and the machine, the parameter settings, formulations, robot sequences, etc. can be transmitted automatically from the mold data set to all the auxiliaries involved. Automating the data transfer to each piece of auxiliary equipment saves time and eliminates the risk of human error.

Beyond its own molding machines, the company offers an option to utilize Wittmann 4.0 outside a Wittmann cell. This is accomplished by connecting the machine and the auxiliary appliances to the TEMi+ MES system. In addition to the normal functionalities of an MES system, the TEMI+ technology supports the extended mold data set.

CONVEYING

Pump is Quiet, Powerful, Energy-Efficient

The multi-stage regenerative impeller design of the new Conair HRG Series vacuum pumps is the key to developing deep vacuum power for conveying plastic pellets over long distances, while keeping noise levels comfortably low. An optional variable-frequency drive is available to save energy and reportedly suits the new pump for use in Conair Wave Conveying systems, which previously required a more costly LDP pump.

Conair says its new hybrid regenerative pumps offer many of the best features of previous designs at a price about 30% lower than a comparable LDP unit. The secret is in the three-stage pump design, with regenerative impellers that smoothly cut, capture and compress the air with minimal draft or vibration. HRG Series pumps can convey material up to 1000 linear ft. Vacuum levels below 12 in. Hg are possible.

HRG pumps are said to be extremely quiet: Operating at 60 Hz, the average sound level is 74 to 77 dBA, a range that does not require hearing protection. The pumps come in three sizes from 11.5 to 42.9 hp.

Instead of moving plastic materials at 5000 ft/min or more, creating dust, angel hair and equipment wear, Wave Conveying uses controlled-speed conveying (300 to 2800 ft/min) to move material in compact slugs, waves or streams. The VFD saves energy by allowing the pump to operate using only the amount of power necessary to achieve the desired material speed and throughput. An HRG pump in a Wave Conveying System was shown to save as much as 50% on energy compared with a similarly sized positive-displacement pump at equivalent throughput rates. Even in standard (non-Wave) operation, savings of up to 25% were observed. In addition to energy savings, the VFD option extends pump life by running only at the capacity necessary.

The new pumps are also "virtually maintenance-free," says Conair: The direct-drive system eliminates drive belts that wear and require constant adjustment. No lubrication is required.

DRYING

Large Dryer Series Makes More Features Standard

Conair's new D Series of large desiccant-wheel dryers, with throughputs from 600 to 5000 lb/hr, focuses on value and intuitive use, according to the company. Now standard features will be accessible to processors via the DC-C programmable electronic control, which Conair developed specifically for drying.

The standard DC-C Premium control system features a 7-in. color touchscreen. Its features include temperature setback, dewpoint monitoring and control, real-time trending, seven-day auto-start/stop, a library of customizable resin-drying recipes, energy-usage metering, audible and visual alarms, and Industry 4.0 and remote-control capabilities.

Conair says it has enhanced the desiccant wheel system in the D Series, adding more precise rotational control for optimal desiccant heating, cooling and drying performance. This release follows the 2018 introduction of a redesigned line of small and medium-sized portable dryers for throughputs from 15 to 400 lb/hr (6.8 to 181 kg/hr).

Conair believes the standard D Series package of features will meet the needs of 90% of its customers. It also offers advanced options for processors with greater demands. For example, the energy-saving Optimizer package adds a variable-frequency blower drive, drying-monitor probe, return-air dewpoint monitor, volatile trap, and process-filter monitor. The DC-C Optimizer control is described as an augmented version of the D-Series Premium control that uses the same interface. The Optimizer package is recommended for PET processors who need to manage high-throughput, high-temperature drying operations where energy management can provide a quick ROI.

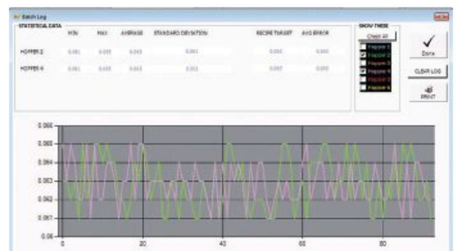
Conair says customers can pair the new standard D Series control with its ResinWorks centralized resin-handling and preconditioning system. In this setup, a large D Series dryer can be combined with a ResinWorks sled containing multiple temperature-controlled hoppers. The new control would allow a processor to manage the entire sled directly from the dryer.

BLENDING

'Smart' Software Saves Labor Costs, Boosts Quality

BlendTrac is AEC's new software program for data automation of gravimetric blenders. It collects and presents useful data to help processors centralize inventory control, optimize quality and reduce labor and material costs.

BlendTrac brings inventory monitoring to a central computer system while adding additional data monitoring to optimize quality and reduce expenses. BlendTrac can look at multiple blenders within a facility or all over the country, offering processors an easier, more efficient way to manage inventory.



Compatible with Windows 10, this software can monitor and control up to 100 BD and OA batch weigh blenders. It can also log up to 1000 alarms per blender and up to 5000 consecutive batch weights. It stores an infinite number of recipes and can download recipes to blenders. Also, it can automatically generate time- and date-stamped reports on an hourly basis and track material reference numbers, lot numbers and silo numbers. This can help link material usage and specific jobs if a quality issue arises with a certain resin lot.

Operators can utilize BlendTrac to reduce part costs by reducing the use of expensive additives. For example, a job may specify a 4% setpoint of additive with a 1% allowed tolerance. With the information BlendTrac provides, operators can adjust the process and stay close to the low tolerance limit of 3%, reducing expensive additive usage.

BlendTrac can be added to new AEC Batch Weigh Blenders or installed on older versions.

HEATING/COOLING

TCU Packs More Output into Same Footprint

Delta T Systems extended its Eco Series temperature-control unit (TCU) with a new "stacked" model featuring a common water supply and common electrical supply inside the cabinet to save space. The Eco Series features a new pump that reportedly creates 50% to 100% greater flow at the same pressure point on the pump curve compared with other designs. The resulting energy consumption complies with the new DOE standard that became mandatory in January 2020.

The series is available with pumps rated from ¾ to 3 hp, which can produce up to 130 GPM of output in each tank. The increase in pump output allows customers to select a lower-horsepower motor, thus lowering the TCU's energy consumption by 20% to 50%. Each pump has its own control, resulting in two independent units with different setpoints to control two processes or molds. Delta T also offers a rebuild kit to separate the units in the future if needed.

The two-tank design allows for a maximum of 24 kW of heating in the standard unit, for water temperatures up to 300 F. Alternatively, the second tank can be used as a water-to-water heat exchanger for indirect cooling.

HEATING/COOLING

Insulation Blanket Beats the Heat, Improves Safety

Shannon Global Energy Solutions has developed and tested a proprietary removable and reusable thermal-insulation blanket, LT550SG, to improve safety of plastics processing machinery. Airlite Plastics Co., an injection molding and extrusion processor, recently installed Shannon insulation blankets on one of its extrusion lines in Nazareth, Pa., to improve safety and reduce ambient heat. The reusable blankets cover a Davis-Standard extruder, extrusion die and related piping.

The project started with installing a Shannon reusable blanket on the processor's boiler and steam system, recalls Tony Alfieri, v.p. and general manager for Airlite Plastics' Nazareth facility. That led to a discussion about extruders. Airlite's sheet extrusion dies operate at up to 400 F, putting a lot of heat into the air.

Alfieri notes that the reusable blankets' design includes openings to adjust the extrusion line without removing the blanket. The blankets eliminate temperature swings in the area around the equipment. Operators no longer need forearm protection for safety because the blankets serve that role.

"The best compliment for the reusable blankets come from our machine operators, who continue to remove and replace these blankets once a month to make routine adjustments and perform maintenance," adds Alfieri. "The blankets aren't required for processing; my guys would have put them in a box after the first time they removed them if they weren't beneficial, easy to take off, and easy to put back on." Airlite plans to install Shannon reusable insulation blankets on the Nazareth plant's remaining lines.

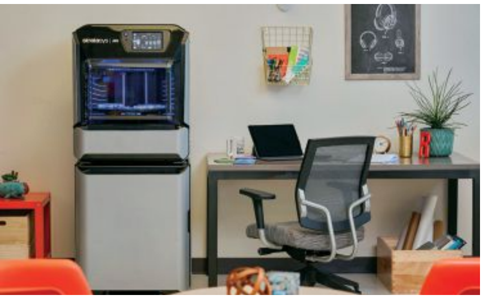
ADDITIVE MANUFACTURING

New 3D Printer Aims to Validate Product Designs Quickly

Stratasys Ltd. launched the new J55 3D printer, which is aimed at professional designers and engineers. The company claims that setup is easy, and remote monitoring means print jobs can be managed from home. This printer uses the PolyJet process, which jets liquid photopolymers that are cured by UV light.

Built as a smaller complement to the Stratasys J8 series for enterprise shops, the J55 supports the full design process with same-day send-to-print and minimal post-processing.

The J55 printer features a maximum build volume of 1340 in.^{3} and occupies only 4.6 ft^2 of floorspace. The five-material capacity (plus support material) means operators can load their most frequently used resins and avoid downtime associated with material changeovers.



In operation, the Stratasys J55 features a patented rotating build platform with a fixed print head. This is designed to maximize reliability and simplify maintenance. The technology also means greater output from a small footprint while also eliminating most sound. It also features the Stratasys ProAero filtration technology for odor-free operation.

Fully supported by GrabCAD Print software, the J55 enables smooth import of common CAD files (e.g., SolidWorks, CATIA, PTC Creo, Siemens NX, Inventor file types) and the latest 3MF file format, a reported improvement over traditional STL, OBJ, and VRML files. For the first time, Stratasys is also adding support for 3MF color workflow with KeyShot 3D rendering software from Luxion Inc., a capability now in beta and planned for late 2020. The J55 3D printer gives designers full CMF (color, material, finish) capabilities. It uses PolyJet materials, including a full range of textures, transparency with VeroClear (VeroUltraClear availability later in 2020), X-Rite-based color profiles, and Pantone validated color. The J55 is expected to ship in July 2020.

MATERIALS

Medical TPEs Adhere to Engineering Plastics

A new series of TPEs for overmolding reportedly exhibits excellent adhesion to a broad range of engineering thermoplastics while meeting the stringent requirements for use in medical devices. Medalist MD-30000 Series from Teknor Apex Co. bonds to PC, ABS, PC/ABS, copolyester TPE, PET, PBT, ASA, SAN, PMMA, acetal, nylon and PS. Each compound in the series is chemically modified for adhesion to specific substrates.

The new series includes grades with enhanced softness, translucence, low compression set for effective sealing, and resistance to lotions and other chemicals encountered by wearable devices.

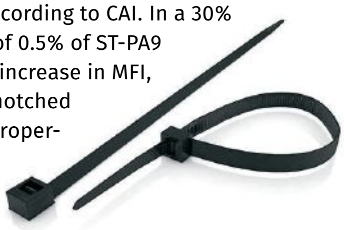
Teknor has developed an online resource for overmolding TPEs, which can be accessed at ***teknorapex.com/overmolding-academy***. It contains basic information about overmolding and adhesion, guides to process and material selection, and case studies.

ADDITIVES

Flow Enhancer for Nylons, PPA, PBT and PLA

A proprietary flow enhancer for nylons and other engineering resins is newly available from Boston-based CAI Performance Additives. CAI is the exclusive distributor in North America for Asian manufacturers of high-performance plastic additives.

ST-PA9 is a non-toxic, highly miscible organic compound that comes in powder form for compounding with nylons 6, 66 and 1012, as well as PPA and PBT, at a low dosage of 0.5%. It also shows promise in PLA, according to CAI. In a 30% glass-filled nylon 6, addition of 0.5% of ST-PA9 reportedly resulted in a 173% increase in MFI, along with a 10% increase in notched Izod impact, while retaining properties such as flexural modulus, tensile strength and elongation.



ADDITIVES

Low-Haze Oxygen Scavenger for PET

A non-nylon-based, low-haze oxygen-scavenger additive for PET rigid packaging has been launched by Polyone Corp. Polyester-based ColorMatrix Amosorb 4020G reportedly offers up to 50% lower haze and less impact on the PET recycle stream than previous grades, while maintaining the same reliable active oxygen-scavenging performance. The new additive is available with applicable regulatory approvals.

Additives are often included in PET packaging to help protect contents and extend shelf life, but they can decrease packaging clarity. New ColorMatrix Amosorb 4020G has been shown not only to help reduce haze, but also to reduce yellowing by 50% during mechanical recycling.

PolyOne's testing shows that effectiveness of ColorMatrix Amosorb 4020G is affected negligibly by the presence of recycled PET, while other competitive materials lose almost all oxygen-scavenging ability with rPET content as low as 20%.

MATERIALS

LCPs Designed for 5G Cellular Communications

Two new liquid crystal polymers (LCPs) boast very low and consistent dielectric constant, very low dissipation factor (loss tangent), and broader temperature and humidity ranges suitable for varied interconnect environments. Launched by Sumitomo Chemical Advanced Technologies, Phoenix, Ariz., the company's latest LCPs were developed in response to the critical role of 5G cellular technology in the successful rollout of affordable, safe, and reliable Level 52 vehicle autonomy. The company is also offering data to help electrical engineers better understand and simulate the performance of these materials for applications such as connectors, cables, and other components that deliver very low latency and signal loss.

Sumitomo Chemicals' new SumikaSuper E6205L and SumikaSuper SR1205L are two thermotropic, injection moldable or extrudable polyester-based LCP grades specifically formulated for 5G applications. Available in natural and black, both are characterized by lower dielectric constant than standard LCP grades—a property necessary to enable reliable, higher-volume data transmission. Owing to its new base chemistry, SR1205L is further distinguished by its lower dissipation factor (loss tangent), critical for ensuring reliable data transmission even in the gigahertz/millimeter-wave frequency ranges. Novel chemistry and polymerization technology also bring other benefits to the SR1205L grade.

Testing shows that the polymer offers very consistent dielectric constant over a broad range of temperatures (-40 to 120 C) and frequencies (1 to 25 GHz) and does a better job of retaining its tensile strength than standard polyester-based LCPs, even at high temperature (120 C), relative humidity (100% RH), and pressures (2 atm) for up to 200 hr, thanks to higher hydrolysis resistance. Initial testing of E6205L shows similar trends. In other physical, mechanical, and processing properties, the new grades perform much like standard LCPs.

ADDITIVES

VOC-Extraction Additive Masterbatch for PP, TPO

A new VOC-extraction additive masterbatch is designed for removal of smelly volatile organic compounds (VOCs) during compounding of filled PP and TPO. Newly available to the North American market, LDV-1025T is available exclusively from Boston-based CAI Performance Additives, a distributor for Asian manufacturers of specialty plastic additives.

The proprietary additive masterbatch has a porous PP bead carrier infused with chemical agents with surfactant properties that have an affinity for charged VOCs, along with a fragrance component. According to company president Richard Marshall, microfoaming takes place as the agents are released during the compounding of PP or TPO, permanently removing the VOCs at the end of the extrusion compounding process. At typical use levels of 0.5% to 2%, the additive also eliminates surface "blooms," while retaining mechanical properties. The product is qualified according to automotive standards, such as those of Volkswagen.

Commodity Resin Prices Plunge in Second Quarter

Weak demand for industrial and durable goods, along with globally lower feedstock prices outweigh strong demand for packaging, medical products.

Prices of all five major commodity thermoplastics have been dropping throughout the second quarter. Despite strong demand for packaging and medical products, the impact of the coronavirus pandemic, coupled with low crude-oil and other feedstock prices, has significantly dampened demand for industrial and durable goods. Nearly all PE, PP, PS, PVC and PET suppliers have throttled back resin production to adjust for weakened demand.

By Lilli Manolis Sherman
Senior Editor

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

Polyethylene Price Trends

Grade	APR	MAY
LDPE	4¢/lb	
LLDPE Butene	4¢/lb	
HDPE Injection	4¢/lb	
HDPE Blow Molding	4¢/lb	
HDPE HMW	4¢/lb	

POLYETHYLENE PRICES DROP

Polyethylene prices dropped 4¢/lb in April, as had been projected by Mike Burns, RTi's v.p. of PE markets, *PCW* senior editor David Barry, and The Plastic Exchange's Greenberg. "A 4¢/lb price decrease seems to be solid for April PE contracts, and the battle for May begins—processors are calling for another 3-4¢ decrease," reported Greenberg at the end of the first full week in May. He said export markets continued to be busy, though prices had fallen sharply to compete with lower international resin prices, fed by falling crude-oil-based monomer costs. "The global polyethylene market is still trying to find a bottom," he concluded.

RTi's Burns characterized the status of the North American PE market in early May this way: With the drastic decline in oil prices, the U.S. has lost its feedstock cost advantage over the rest of the world. "We are now producing PE at a cost equal to everyone else. Plus, we have an extra 40% capacity, which typically has gone to exports. In addition there is a limited number of railcars available." He says North American suppliers will have to cut production and/or sell export material at a loss. He ventured that if oil prices remain low, leading to lower production, natural gas prices will increase and contribute to higher ethane costs. Such an increase will further erode the North American cost advantage for export and could lead to decreases in PE production, keeping prices in North America firm heading into the hurricane season.

Market Prices Effective Mid-May 2020

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	92-94
LLDPE BUTENE, FILM	75-77
NYMEX 'FINANCIAL' FUTURES	26
MAY	24
HDPE, G-P INJECTION	97-99
HDPE, BLOW MOLDING	90-92
NYMEX 'FINANCIAL' FUTURES	27
MAY	24
HDPE, HMW FILM	104-106
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	52-54
NYMEX 'FINANCIAL' FUTURES	38
MAY	31
IMPACT COPOLYMER	54-56
POLYSTYRENE (railcar)	
G-P CRYSTAL	99-101
HIPS	103-105
PVC RESIN (railcar)	
G-P HOMOPOLYMER	81-83
PIPE GRADE	80-82
PET (truckload)	
U.S. BOTTLE GRADE	40-41

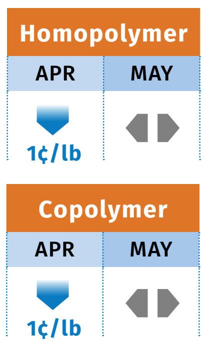
PCW's Barry noted that PE suppliers had positioned themselves for weaker second-quarter demand by cutting back production. Dow, for example, announced it would idle three PE plants and two elastomer units (accounting for about 10% of Dow's global PE and elastomer capacity) for at least one month to match demand trends in the U.S., Europe and Latin America. LyondellBasell executives said the company's U.S. olefins and polyolefins assets were expected to run at approximately 75% of capacity. The company has not seen demand decline to the point where it would consider idling PE plants. ExxonMobil said it was slowing the pace of its plant construction projects.

Barry noted that PE spot prices were mostly unchanged in the first full week of May. He saw potential for another 2-3¢/lb drop, noting the 10-13¢/lb spread between wide-spec and prime PE, as well as a drop in exports. Greenberg said, “Processors have been shrewd, only ordering small quantities, expecting lower prices ahead, and in most cases being very aggressive with low-priced bids.”

POLYPROPYLENE BOTTOMS OUT

Polypropylene prices dropped 1¢/lb in April, following the 4¢ drop in March, in step with April propylene monomer contracts. Both Scott Newell, RTi’s v.p. of PP markets, and *PCW*’s Barry figured that prices were near bottom as monomer supplies tightened because refinery operating rates had dropped below 67%. Both expected PP prices to follow monomer tabs in May. Newell foresaw flat to slightly higher pricing. Barry expected monomer and PP prices to start moving up in May to June, with PP suppliers throttling back production. “There was talk that some producers had reduced throughput to around 75% of capacity,” he reported.

Polypropylene Price Trends



Newell characterized PP demand as “average” in March and most of April, noting that despite the steep drop from automotive, other markets such as nonwovens, food packaging and consumer products were strong. Nonetheless, by the end of April, a slowdown appeared to be taking place, he said, with reports of resin orders being canceled. Medical products were noted as one bright spot in the market, while automotive resin demand, which nearly halted in April, was expected to make a slow recovery.

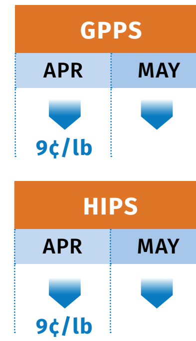
Both Barry and Greenberg saw spot buying activity slow down, though supply was ample. Greenberg reported that his PP homopolymer sales outpaced copolymer. “Also, prime was favored over widespec, as the contract decrease has helped narrow the spread. The market awaits a normalization of demand which could begin to develop as shelter-in-place orders begin to ease.”

POLYSTYRENE PRICES PLUNGE

Polystyrene prices dropped 9¢/lb in April, following one of the largest drops historically in benzene contract prices, down to $1.30/gal from March’s $2.57/gal, according to *PCW*’s Barry and Robin Chesshier, RTi’s v.p. of PE, PS and nylon 6 markets. Spot benzene prices dropped as low as 79¢/gal, before moving up 10¢/gal by the end of the first week in May; and June was projected to rise to 95¢-$1.05/gal, according to Barry. He also reported that spot prices for prime PS had dropped 3¢/lb, due to weaker-than-usual demand. May contracts would likely follow suit.

“Disposable foodservice items were expected to get a lift in the summer as consumers, weary of coronavirus lockdown measures, escaped to the outdoors. So far, this anticipated demand trend has not boosted PS consumption enough to offset the overall weak economic outlook,” reported Barry. Both sources noted that PS suppliers would continue to reduce their operating rates based on demand forecasts. RTi’s Chesshier said she did not expect this year’s seasonal demand to equal that of past years. There were indications that orders from big-box stores were down 30%. She predicted that suppliers would aim to keep prices steady this month. “This situation is creating a new way of looking at things—processors are getting more creative,” she said. There are strong indications that some PS processors have already started qualifying other, more attractively priced, resins—PET, PP or HDPE—particularly for rigid parts such as appliance components.

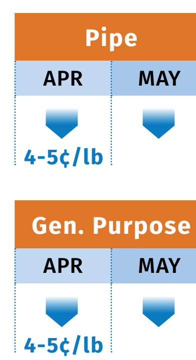
Polystyrene Price Trends



PVC PRICES DROP

PVC prices in April were expected to drop 4-5¢/lb, wiping out the 5¢/lb gained by suppliers in the first two months of the year. Another drop in May of about 3¢/lb was likely, according to Mark Kallman, RTi’s v.p. of PVC and engineering resins, and *PCW* senior editor Donna Todd. Demand in the major construction sector was down by as much as 30% going into April, and May was expected to be worse. Said Kallman. “I think we’ll see some start of recovery in June, but real recovery won’t be seen until the third quarter.” He saw medical e-commerce and retail sectors for PVC as doing relatively well.

PVC Price Trends



PCW’s Todd characterized the PVC market as still in “defensive mode” at the end of the first full week of May, with suppliers and processors navigating through the uncertainty brought on by COVID-19. “The normal spring demand season has been delayed more in some places than others due to the differences in the shelter-in-place orders enacted by the various states. As of this week, most states were opening their economies back up to some extent, though each was taking its own approach to returning to a ‘new normal’,” said Todd. Both sources reported that suppliers were aiming to keep their inventories in check via maintenance turnarounds or throttling back production. Plant operating rates were said to be below 80%, with some suppliers at 60% to 75%.

PET PRICES DOWN

PET prices started May in the low 40¢/lb range for domestically produced resin in railcars and truckloads (delivered), down from the mid-40¢/lb range in early April. *PCW* senior editor Xavier Cronin thought prices would drop as much as 5¢/lb by June, due to the collapse of crude-oil prices and the resulting drop in tabs for paraxylene and other PET feedstocks. He said, "Supply for end users is readily available for spot and contract deliveries, from U.S. production/storage locations and imported PET from around the world. At the same time, demand for PET is rising in the consumer sector as demand for bottled water and other carbonated beverages continues to rise due to the COVID-19 outbreak."

PET Price Trends

Bottle Grade	
APR	MAY
◀▶	▼ 3-5¢/lb

Meanwhile, Cronin reported that demand for food-grade rPET is strong. Spot and contract business in early May was steady from April, in the high 60¢/lb range for truckloads delivered. This demand is driven mainly by consumer-brand companies under pressure to blend more recycled plastic into their bottles and other packaging.

QUESTIONS ABOUT MATERIALS?

Learn more at PTonline.com

Visit the Materials Zone and the Materials Database.

Plastics Processing Business Continued Contracting in April

Global economic shutdown causes downturn in new orders and production.

By Michael Guckes
Chief Economist/Director of Analytics

Gardner Intelligence's Plastics Processing Business Index experienced unprecedented deceleration of most measures of business activity in April. The reading of 33.4 was more than 10-points below both the prior month's low and the previous cyclical low of 2015.

New orders, export orders, production and employment set new all-time lows for the second time in two months.

Perspective: These readings represent the breadth of change occurring within the processing industry and are not to be confused with the rate of decline taking place. They indicate *only* that a large proportion of the industry reported decreased levels of each business activity type.

Efforts to slow the spread of COVID-19 further worsened the disruption to the industry's supply chain in April. The slight rise in supplier deliveries indicates a further slowing of deliveries and implies a worsening disruption of supply chains. The reading for supplier deliveries is designed to increase when the pace of orders slows, under the assumption of growing upstream backlogs resulting from strong demand. However, at present, the economic disruption caused by COVID-19 is disrupting normal economic activity and causing the observed delay in delivery times.

For the first time since 2016, the index for prices received fell below 50 while the index for material prices moved above the 50-mark. This combination of events suggests that profit margins are under increasing pressure because of recent events.

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

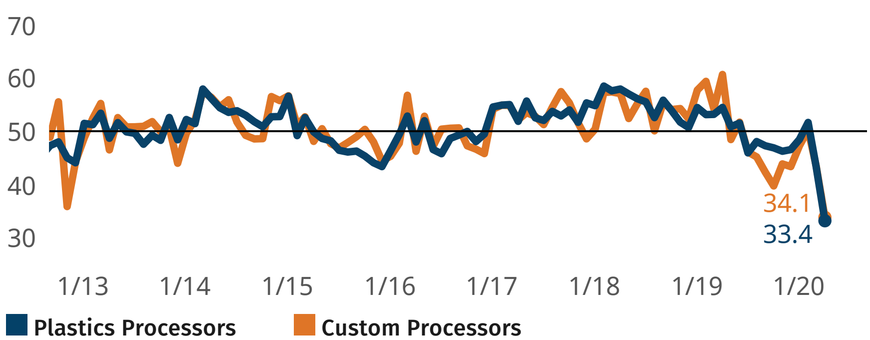


FIG 1

Business activity contracted at an accelerating rate in April to levels not previously experienced. As the economic slowdown across the country and globe continues, plastics processors have reported a severe decline in new orders and production activity.

Custom Processors: Material Prices & Prices Received (3-Month Moving Avg.)

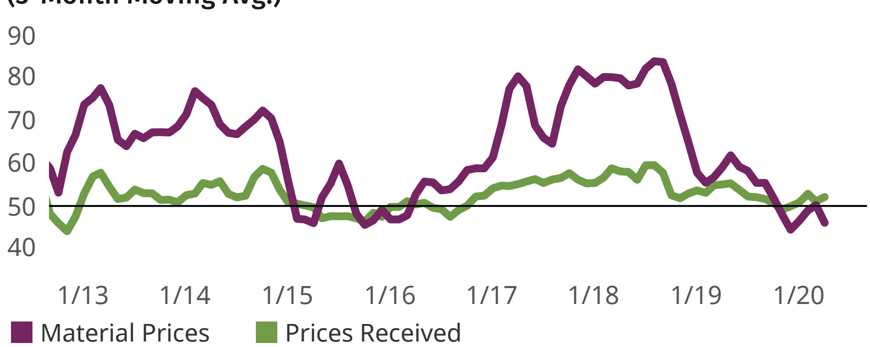


FIG 2

Despite a challenging first quarter of 2020, custom processors reported that their prices for goods sold has improved, along with a slight decrease in material prices. While this is subject to change in future months, the combination of events implies that profit margins may have improved in the first quarter.

infoNET

This is *Plastics Technology's* online listing for plastic processing equipment builders, material suppliers, auxillary manufacturers and more.

WWW.LEISTRITZ-EXTRUSION.COM

Leistritz

We manufacture twin screw extruders for compounding and also for 3D filament production! Contact us today for the Leistritz Twin Screw Report newsletter and upcoming seminar dates at *sales@leistritz.com*

WWW.WITTMANN-GROUP.COM

Wittmann Battenfeld

Wittmann Battenfeld's website provides global access to the full range of Battenfeld injection molding machines, process engineering, customer service, training and turnkey solutions, in addition to automation and auxiliary equipment including Wittmann robots and automation, material conveying, drying, blending, granulating and water temperature controllers.

WWW.NOVATEC.COM

NOVATEC™ The Power of Touch

World's largest selection of dryer technologies and blenders with unmatched system design and control capabilities. 1-800-BESTDRY (1-800-237-8379)

WWW.MAGUIRE.COM

MAGUIRE® Intelligent Simplicity

Over 100 pages of easy browsing packed with useful information on Maguire Blenders, Loaders, Granulators, Feeders, and Liquid Color Pumps.

infoFILE

Monthly Resource Guide

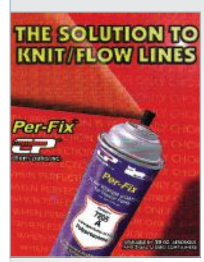
You can get copies of literature from suppliers listed on these pages by sending an e-mail to the address provided at the end of each writeup. Or, where provided, contact the company by phone or fax.

HYBRID HIGH-PERFORMANCE MODELS-

Fortune VsP Series has been developed by fusing of merits of the injection machines (low maintenance operation, long life, and lower cost) and hybrid injection machines (energy saving, high-velocity injection, quick response, high repeatability, and lower operation noise).

Somerset, NJ • sales@fortune-cnc.com

THE SOLUTION TO KNIT/FLOW LINES



Per-Fix™ Flaw Repair Coatings—The Solution to Knit/Flow Lines. Chem-pak's patented line of coatings helps you eliminate most cosmetic flaws common to injection molded plastics. Designed specifically for matte-finished, color-coded, textured, interior parts.

Martinsburg, WV • info@chem-pak.com

DRY-CONVEY-BLEND-EXTRUSION

Novatec is one of the largest U.S. based manufacturers of resin drying and conveying equipment for the plastics industry. Together, with Maguire Products, we offer the largest line of manufactured resin handling equipment in North America. Product Overview: www.novatec.com/about

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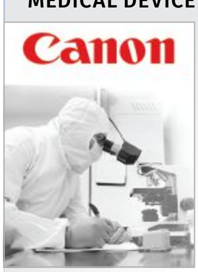

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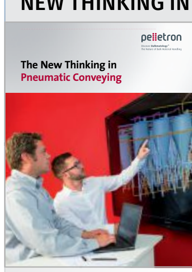

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PLASTIC INJECTION MOLDING INC. — RICHLAND, WASH.

For Medical-Parts Molder, Better Chemical Resistance Just 'Drops In'

Switch from PC/ABS to Eastman Tritan MXF copolyester helps PIM meet need for greater resistance to a wider range of disinfectants with no processing tradeoffs.

New grades of Tritan MXF copolyesters from Eastman aim at medical-device housings, where they can reportedly withstand a wide range of disinfectants without discoloring or failing. Photos above show ultrasound device (left) and a ventilator.

By Jim Callari
Editorial Director

Want to see a skeptical molder? Tell him about a new material that will run on existing presses and tooling with little or no modifications—a "drop-in replacement." Yet that was essentially the recent experience of custom molder Plastic Injection Molding Inc. (PIM), Richland, Wash., when it began transitioning from PC/ABS to new grades of Tritan copolyester for electronic medical housings and hardware used in patient monitors and other hospital equipment.

At MD&M West 2020 in Anaheim, Calif., Eastman unwrapped a collection of flame-resistant (FR) medical grades of Tritan MXF specialty copolyesters specifically suited to the rigors of patient-care hospital equipment. The MXF product line launched last year with Tritan MXF121, which is built on Tritan's proven durability and disinfectant resistance—a key consideration in hospitals, considering all the different types of disinfectants they use, and a particularly topical matter now as a result of the coronavirus pandemic.

PIM is switching from PC/ABS to Eastman Tritan MXF for more than 100 parts it supplies for patient-care instruments and devices, including this overmolded thumb wheel.

The portfolio now includes FR grades with a UL 94V-2 flame rating. These materials reportedly offer unsurpassed chemical compatibility with a wide range of disinfectants used to combat HAIs (healthcare-associated infections), as well as improved durability and higher impact strength. Tritan MXF is said to be easy to process and to require lower ejection force for easier demolding.

Brad Potter, marketing director for Eastman Specialty Plastics-Medical, says Tritan MXF copolyesters can help OEMs save money across the value chain due to reduced repairs, returns and warranty claims from device breakage; a low scrap rate; and the fact that retooling is unnecessary when changing from PC/ABS. He notes, "Switching to Tritan MXF adds value throughout product design and commercialization and ultimately lowers the cost of ownership. Most importantly, using Tritan MXF polymers in medical-device housings enables healthcare workers to clean those devices more thoroughly with proper disinfectants, ultimately reducing the incidence of HAIs and positively impacting patient outcome."

In business for almost 25 years, PIM runs nine presses in its original building and recently completed an additional 28,000 ft² plant expansion housing six additional injection molding machines. Tonnage ranges from 25 to 300 tons (shot sizes from 1.5 oz to 30 oz).

In a project initiated by an unidentified OEM that furnishes patient-care equipment to hospitals, PIM started running Tritan MXF last fall. Says company president Ken Williams, "For one day, we shut down the plant and ran Tritan MXF on a dozen different parts. We ran four different grades of the material, including lower-flow grades with higher chemical resistance and higher-flow versions with lower chemical resistance. It was a relatively straightforward transition. We ran the molds a bit cooler, the level of shrink was similar, and for both processing and secondary operations such as pad printing and ultrasonic welding, everything was pretty straightforward."

PIM (***qualityplasticparts.com***) runs about 100 different parts for this OEM on 57 molds. Switching from PC/ABS to the Tritan MXF portfolio required only minor tooling modifications—increasing the gate area—recalls Troy Stivers, PIM's v.p. of manufacturing. PIM made the modifications in its in-house toolroom.

For this OEM, Williams notes that PIM will be phasing out PC/ABS over time. "We've recently received a large order and will be ready for more when the PC/ABS parts reach the end of their life-cycle," he told *Plastics Technology* back in March.

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