Let’s Get Ready to Recycle

IN THIS ISSUE:

• 2020 Division Scholarship Winners
• The Benchmark ABS for Extrusion
• 2020 PET Thermoform Recycling
Accelerate Revenue Growth With Shorter Lead Times

GENESIS PROGRAM

The Genesis Program is a comprehensive inventory of stock machines, parts and sub-assemblies that enables expedited deliveries of complete sheet extrusion systems. Represented within the scope of the program are ancillary components, including: individual extruders, roll stands, die supports, winders and pelletizers available for complete line configuration and delivery within three months.

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  - gear pumps
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The Genesis Program results in the immediate availability for a variety of sheet extrusion system configuration combinations. The reduction in lead time for these systems represents a significant factor for expediting the product-to-market timing and the pathway to financial success.

Time is Money!

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<th>Delivery Reduction (weeks)</th>
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** Production Revenue figures assume: rate x 5 days per week of delivery reduction x 24 hours/day x $1/lb product sales/cost price.

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Bales of PET thermoforms awaiting processing back into valuable materials. Photo courtesy of NAPCOR.
I hope everyone is doing well as we enter the holiday season. Shorter days lead to darker nights, but as we gather with family in trying times, let us reflect on all that we have seen in this unique year. As we continue to deal with our new normal, we adapt and act quickly to make decisions. Although the pandemic has forced us to change directions, sometimes putting major obstacles in our path, we have been able to plough forward, if a bit more slowly than before.

Our board members continue to work closely together focusing on our pledge to fulfill the mission of SPE Thermoforming Division and provide more value to members while promoting the industry beyond our group. Because we are unable to participate in conferences in person as planned, we have focused on how to develop and optimize our virtual presence.

Since the last issue, we have put a major emphasis on webinars. Division members and sponsors participated in “Plastics in Food Packaging” with a focus on thin gauge-thermoforming and sustainable materials. See “SPE Round Up” on p. 35 for more details. We continue to work with local SPE chapters in different geographical areas to plan multi-day virtual topcons (“topical conferences”). Our division will offer presentations on materials and processing to increase awareness among SPE colleagues of what thermoforming can do compared to other plastic converting technologies.

That said, I am excited to announce that our first educational webinar will be in January (see full page ad on p.10). With this first webinar we are targeting the design engineering community. We will host a 1-hour interactive presentation where we will focus on converting sheet metal parts to plastics with exciting case studies. This will be promoted widely so that we can increase awareness to those who may not know us. We encourage members to sign up and to spread the word via social media channels.

In this issue of the magazine, we celebrate our annual scholarship winners (see pp. 12-15). Funding the next generation of thermoforming designers and practitioners is a key pillar in our mission statement. We look forward to convening at the next conference to celebrate these students and their accomplishments. Our lead technical article (pp. 16-29) focuses on ABS, a well-known material but one that offers processing challenges in certain environments. In our sustainability section, we share some news and developments in PET recycling (pp. 30-31). It’s not always about bottles.

I do miss seeing all of you in person. Our virtual presence is a great way for us to stay connected, but we look forward to the day when we can sit down together, sketch out new projects, and collaborate. As I commented on a LinkedIn post a few weeks back, SPE Thermoforming Division is on a continuous journey. We are a thriving industry today because of the great contributions and efforts of many. We will go further together.

Until we meet again, I wish all of you the very best. Stay Safe!
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* time machine is actively producing parts; across all machinery groups; based on data gathered from ILLIG worldwide customer base
Prent to Invest $12.5M in NM Facility

Sarah Kominek, Plastics News

October 9, 2020 - Janesville, Wis.-based Prent Corp. will invest $12.5 million to open a new, 62,500-square-foot manufacturing facility in Santa Teresa, N.M., to double its capacity in the next five years.

The new location will create 85 new jobs with an expected average full-time wage of $26.14 and a part-time wage of $15.75, an Oct. 8 news release by the state's economic development department said.

The state of New Mexico will support Prent's move into the new location, it said, with $500,000 in economic assistance from its Local Economic Development Act fund, a job creation or closing fund.

"Prent is also receiving economic assistance from Doña Ana County with a proposed IRB ordinance that goes to public hearings in the coming weeks," the release said.

Operations at the new location are expected to begin in the fall of 2021, with construction to start as soon as approvals are in place, it said.

“Like other Prent sites, the facility will be ISO 13485-certified, have a Class 8-certified clean room and utilize the same Prent-designed and -built thermoformers used globally,” the release said.

The sterile barrier packaging produced by Prent for medical devices requires the facility to pass an audit by its customers, it added. “Passing the audit offers Prent more supply chain certainty because the industry has high regulatory barriers for any new competition.”

The new manufacturing facility will give the company a total of 11 sites.

“For over three years we've worked closely with partners in the region to make this a reality," Mark Rothlisberger, senior vice president of manufacturing for Prent, said in the release. “Over and over, we heard that the strength of the region is its collaboration across borders. Today's announcement is a vindication of that model, one integrated region working together towards success.”

Prent ranks No. 17 in Plastics News' current survey of North American thermoformers, with estimated annual sales of $175 million.

Yakima Plastics Plant to Close in December

By Mai Hoang, Yakima Herald-Republic

October 26, 2020 - Sonoco plans to close its Yakima plastic thermoforming plant in December, according to a notice from the state Employment Security Department.

According to the Worker Adjustment and Retraining Notification, or WARN, 133 workers will lose their jobs with the closure, which is expected to happen around Dec. 20.

Sonoco, based in Hartsville, S.C., has been operating the plant at 2801 River Road since 2017. Prior to that, California-based Peninsula Packaging operated the Yakima plant for five years before Sonoco acquired the company. The plant had been producing a variety of packaging for agricultural commodities, such as apples.

Brian Risinger of Sonoco told the Yakima Herald-Republic the closure is due to macroeconomic conditions impacting produce packing operations, challenging conditions on the West Coast and Mexico and the loss of a large customer connected to the Yakima plant. The company is consolidating its West Coast operations to align with market conditions and customers, he said.

“The Yakima community has been very supportive, as has the local government leadership,” he said in an email. “It's a great place to do business, we just had to make some tough decisions about our overall West Coast operating footprint, as well as realigning one of our facilities in Mexico.”

Sonoco is looking for a buyer for its Yakima facility, he said.

According to a news release, Sonoco reported net sales of $1.31 billion during the third quarter of 2020, a decrease of 3.1% from the same period a year ago.
Klöckner Pentaplast to expand production facility in Beaver, WV

By Yazmin Rodriguez, Regional Affiliate ABC 4 WOAY (woay.com)

November 16, 2020 - BEAVER, WV (WOAY) - Gov. Jim Justice announced today that Klöckner Pentaplast, a global manufacturer and supplier of sustainable packaging products, has chosen its production facility in Beaver for its production expansion, adding thermoforming capabilities to further grow their sustainable food tray offer for the North America market.

With this expansion, Klöckner Pentaplast, also known as kp, supports the continuous, increased demand for a higher percentage of post-consumer recycled content (PCR), in various food, consumer and health packaging applications. The investment will bring about several million dollars in economic development to the area and create 21 full-time jobs.

“This is truly a great day and a terrific announcement,” Gov. Justice said. “I want to thank all the good people at kp from the bottom of my heart for their commitment to West Virginia and Beaver, and for being a strong local employer over the last 20 years.

“Expansions like this are just more evidence of all the goodness we have going on right now in West Virginia,” Gov. Justice continued. “From bringing in surplus after surplus, all with no new taxes, to getting to a point where we can look into pathways to potentially eliminating the state income tax, a lot of people on the outside are realizing that West Virginia is the diamond in the rough they’ve all missed.”

“Klöckner Pentaplast is very pleased to announce this expansion today along with Gov. Justice and representatives from the State of West Virginia and Raleigh County Commission,” said Klöckner Pentaplast’s representative, Mark Gonyar. “We’ve been honored to be part of West Virginia’s economy these last 20 years and look forward to continuing our partnership with the state for many years to come.”

Klöckner Pentaplast’s broad portfolio of packaging and product films and services are used in the sustainable food packaging, consumer goods as well as pharmaceutical and medical device industries. The company’s packaging protects product integrity and brand reputation while assuring safety and consumer health. With global sales exceeding $2 billion, the company is also a leader in sustainability and partners with retailers, recyclers and other groups to eliminate plastic waste and pollution.

“With expansions over the years, Klöckner Pentaplast has proven that they believe in West Virginia,” said West Virginia Secretary of Commerce Ed Gaunch. “I want to thank them for choosing our incredible state for this expansion and for continuing to enhance the local economy and further develop our workforce.”

The company established its facility in Beaver in 2000. Klöckner Pentaplast chose to expand its operations in West Virginia due to Beaver’s proximity to customers, local workforce availability, and regional transportation infrastructure.

“Raleigh County is honored that Klöckner Pentaplast has chosen to expand their operations in Beaver, West Virginia,” said Raleigh County Commission President, Dave Tolliver. “We stand ready to continue to support their company as they positively impact Raleigh County and the New River Gorge region with their dedication to creating great jobs in southern West Virginia.”

Founded in 1965 in Montabaur, Germany, Klöckner Pentaplast has operations in 18 countries and employs more than 5,900 people committed to serving customers worldwide in over 60 locations, including 32 production sites.

“From the standpoint of kp, we want you to love West Virginia and embrace West Virginia like you never have before, because we are really on the move,” Gov. Justice said. “As we continue on the move, I promise we will never lose sight of the fact that West Virginia really appreciates you.

“West Virginia truly loves you for being here, and we want you to be so successful it’s unbelievable,” Gov. Justice continued. “I’m a business guy and we want you to be extremely profitable in all that you’re doing.”
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Mercury Plastics Adds East Coast Site with Maryland Thermoform Acquisition

Don Loepp, Plastics News Editor

November 24, 2020 - Mercury has purchased the assets of Maryland Thermoform Corp., a Baltimore-based company that focuses on thermoforming thin-gauge blisters and also has a growing fabrication department.

Mercury bought MTC from President Jim Hall and CEO Scott Macdonald. Terms were not disclosed.

The two companies had “absolutely no customer overlap,” David Goldman, director of the materials management group at Mercury Plastics, said in a Nov. 24 telephone interview. He also highlighted that Mercury will be able to supply MTC with sheet.

“We’re able to extrude our own materials in house,” he said. “That’s powerful. That’s one of the biggest reasons for this deal, the synergies.”

MTC had a working capital deficit, Goldman said. Mercury President and CEO Rick Goldman said MTC will see some equipment upgrades but otherwise stay the course.

“We’re going to clean the place, put our touch on it and let them continue to do their thing. They do good work,” Rick Goldman said. “We’re looking to share ideas and create synergies between the two companies.”

He added: “In the midst of the largest pandemic in over 100 years, we are humbled to be able to step in and help this company to once again be a formidable East Coast presence and to save the jobs of the hardworking employees at MTC.”

MTC has a 60,000-square-foot factory in Baltimore with 10 thermoforming lines and handles both thin- and thick-gauge sheet. The company serves government, OEM, cosmetics and consumer packaging customers. In late 2019, MTC started a fabrication department that is now known for museum-quality installations. MTC also has its own stock line of candle packaging clamshells and trays.

MTC is ISO 9001 certified and has 45 employees. The company ranked No. 112 in Plastics News’ annual survey of North American thermoformers with estimated 2019 sales of $9 million.

David Goldman said MTC’s sales have slipped a bit in 2020. Early on in the pandemic, the company retooled to make face shields and intubation boxes for health care workers as well as shielding for retail stores. Mercury also saw a shift in its business because of COVID-19.

“We’ve been open through most of it. We shut down for a few days before we realized what ‘essential’ actually meant,” Goldman said. Plastic sheet sales helped, especially glycol-modified PET.

“When PETG started to get scarce, a lot of our customers started reaching out,” he said.

Mercury, which Plastics News has not ranked, has 28 thermoforming machines, four extrusion lines and annual sales of about $35 million, not including MTC. That would have tied for No. 52 in PN’s 2020 ranking.

Mercury Plastics was founded in 1955 but has mostly kept a low profile. It has done asset purchases in the past, but this is the first time that Mercury has bought a company and kept it open as a going concern. Doing the deal was complicated by the pandemic.

“We took our first drive out there in July. It was an 11-hour drive, and we spent a day and a half there. We met everybody and got the lay of the land,” Goldman said. “Except for that visit, everything was done remotely. There was a lot of building trust, building a relationship, over phone calls and Zoom calls.”

Mercury makes point-of-purchase displays and a wide variety of packaging, including food, consumer brands, dunnage and OEM part trays. Before the acquisition, Mercury had two manufacturing facilities and a warehouse for a combined 309,000 square feet of space.
2020 Division Scholarship Winners

University of Massachusetts Lowell

A senior at the Francis College of Engineering/Honors College, David anticipates graduating with a Bachelors of Plastics Engineering degree in Spring 2021. He is a member of the Dean’s List, and the Tau Beta Pi National Engineering Honors Society, whose members are in the top four percent of the College.

David has experience as a research assistant on two teams: one which worked to recycle a natural polymer, chitin, into lucrative byproducts, and another that worked to implement closed-loop process control into the FFF 3D printing apparatus. During the summer of 2020, he interned at SMC, Ltd, where he learned about injection molding machines, new process development, mold maintenance, and mold design. During the Fall of 2019, David interned at the Haartz Corporation, where he learned about tooling design, new material development, additive compounding, and twin-screw extrusion.

In January 2020, David co-founded UML3D, the university’s first 3D printing club where he currently serves as co-president. His club led a massive fundraiser that funded a club-wide marathon of producing thousands of articles of PPE for local nurses, special education teachers, and other essential workers. They recently upgraded their designs using laser cutting to create higher quality face shields using extruded sheets of polycarbonate instead of their previous design of vinyl.

David is a member of the Society of Plastics Engineers (SPE), the New England Rubber and Plastics Group (NERPG), the Society of Manufacturing Engineers (SME), the American Chemical Society (ACS), and the ACS Rubber Division. He is also a youth soccer high school league coach and a UMass Lowell Intramural Sports Team Captain (Soccer, Frisbee, Handball, Volleyball, Basketball).

David’s extracurricular engineering projects have been driven by his interest in 3D printing. He currently owns two printers: a Prusa i3 Mk3 and an Anycubic Photon. David has developed a series of open-source assistive devices for his cousin, which included adaptive Xbox controllers and simple prosthetics that form a specific purpose. He is currently designing complex exoskeleton prosthetics that will utilize the user’s own hand and fingers while running on input signals. David has a design that uses a keypad and is currently working on one that will use a brain-computer interface.

Kettering University

Antonia is a senior studying chemical engineering at Kettering University in Flint, Michigan. She is completing her thesis, conducting research on plasticizers. Antonia first encountered the coatings industry through a co-op with BASF where she assessed paint quality on automobiles. After observing the myriad of things that can go wrong with the final product, Antonia wanted to learn more and interned at PPG in the dispersions and pigments evaluation lab. During her time there, she worked on U.S. Department of Energy test models for dispersion quality using different resin technology. This experience has fueled her desire to become a coatings engineer.
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Laryssa Meyer

At Kettering, Antonia serves as the vice president of Student Government and president of the International Club and has held various leadership roles in the Plastics Engineering Club. Last year, Antonia participated in the 2018 SPE Thermoforming Conference RC Car Race Competition.

University of Wisconsin – Stout

Laryssa is a senior studying plastics engineering, and she plans to graduate in December 2020. She has served as president of the SPE and SWE (Society of Women Engineers) student chapters since May 2018.

Laryssa held three internships with Medtronic: two in an operations environment with the third completed in a materials research and development group. During the summer of 2020, she worked as a virtual intern, researching sustainable packaging materials for current and future packaging assemblies. Laryssa developed action plans to implement material alternatives for future packaging components and facilitated national communication between packaging teams for project coordination and planning.

During her first internship with Medtronic, Laryssa worked as an injection molding intern, where her main project involved increasing capacity on an injection molding press by an additional eight hours per week by qualifying a duplicate mold for production. Her efforts also reduced overtime labor costs by at least $30K annually by cross qualifying a mold to increase manufacturing flexibility. In addition, she led confirmation runs on a molding press to enable cross-qualifications resulting in increased labor efficiency.

At the University of Wisconsin-Stout, Laryssa worked as injection molding and thermoforming research assistants. As a thermoforming research assistant, Laryssa conducted several DOEs to determine optimal thermoforming conditions for multi-layer co-extruded films. She normalized heating time per micron required for varying film thicknesses to determine heat times for films and verified heat transfer calculations by using a professional thermal imaging camera to record films as they reached and exceeded their glass transition temperatures.

Laryssa also served as a manufacturing team member with 3M Fall Protection where she was responsible for coordinating cross-functional team involvement to assemble a variety of fall protection systems across several departments.

Lexington Peterson

Lexington Peterson is a senior at Pittsburg State University in Pittsburg, Kansas. She is a double-major in plastics engineering technology and polymer chemistry.
During the summer of 2020, Lexington was employed as a Process Engineer Intern at iMFLUX, a subsidiary of Procter and Gamble. During the school year, Lexington is actively involved in the Society of Plastics Engineers, Society of Women Engineers, American Chemical Society, Honors College Association, Student Government Association, Alpha Sigma Alpha sorority, Panhellenic Council, Advance ment Ambassadors, Phi Kappa Phi, and the Student Sustainability Fund Committee.

In addition to her academic achievements, Sidney is a student member of the Society of Plastics Engineers, a THON Board Member, and a former NCAA Division III Cross-Country Athlete. She was also a member of the Student Athletic Advisory Committee from 2017-2019, and was previously named Penn College Athlete of the Week and Northeastern Athletic Conference Runner of the Week. Active in the Penn College community, Sidney is a research assistant at the Plastics Innovation and Resource Center (PIRC), and a fitness center student assistant.

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MAGNUM™ ABS: The Benchmark ABS for Extrusion

Mark Vreys, Technical Service Leader, Trinseo, Terneuzen, the Netherlands
Tony Samurkas, NA TS&D Director, Performance Plastics, Trinseo, Midland, MI

Editor’s Note: This paper was first presented at SPE ANTEC 2019 in Detroit, MI.

ABSTRACT

Acrylonitrile-butadiene-styrene (ABS) resins are widely used for applications such as appliances, toys, office equipment, sanitary wares, building & construction, transportation and more. Extrusion of ABS covers around 25% of the total ABS market in North America, namely through sheets, pipes, edge bands, and profiles. ABS extruded into sheets and formed into final parts, finds its way into furniture, automotive, buses, trucks, recreational and utility vehicles, sanitary applications, advertisement boards, luggage and doors. For optimum product performance and cost efficiency, the ABS resins require specific attributes. These are an excellent lot-to-lot consistency, a white and thermal stable base color, an adequate UV stability, a low amount of unmelts and a high product purity. Because sheets and edge bands are demanded in a wide range of colors, self-coloring has become a key cost driver through necessities such as color matching, UV absorbers, and optical brighteners. Limited run sizes and regrinding also lead to increased scrap and constant color adjusting. Because the surface quality of thermoformed parts is so critical, presentation of unmelts and high levels of volatile organic compounds in the resins affect aesthetics.

This study discusses the attributes of ABS specifically for extrusion and thermoforming, and compares the benefits of MAGNUM™ ABS versus several emulsion ABS. It is intended to provide information to manufacturers of extrusion applications to select the most suitable ABS materials for optimum production performance and cost efficiency.

INTRODUCTION

Trinseo is a global materials solutions provider and a manufacturer of plastics, latex binders, and synthetic rubber. In particular, for the plastic MAGNUM™ ABS, Trinseo has production locations in the US (Midland, Michigan) Europe (Terneuzen, Netherlands) and a new production unit for MAGNUM ABS in Zhangjiagang, China, was started up in the third quarter of 2017. All 3 units utilize Trinseo’s proprietary mass polymerization process technology which yields ABS of a superior quality to competitive ABS resins in all geographies. MAGNUM™ ABS delivers excellent performance attributes for extrusion, and its downstream processes of thermoforming and lamination. It is an ideal fit for automotive interiors, buses, trucks, recreational and utility vehicles, appliances, furniture, sanitary applications, and building and construction applications, where aesthetics are important. For end-use applications in which looks matter, MAGNUM™ ABS can be an advantageous choice for customers who need to meet demanding customer aesthetics while keeping fabrication costs down. This paper will focus on describing the benefits of MAGNUM™ ABS for extrusion applications.

THE ABS MARKET IN NORTH AMERICA

Extrusion of ABS covers around 25% of the total ABS market in North America. There are four subcategories in the ABS extrusion market: sheet, pipes, edge bands, and profiles. Sheet and pipes are the largest applications, followed by edge bands, whereas profiles are of a smaller volume and more fragmented.

The ABS extrusion market has a wide diversity of applications. ABS extruded into sheet finds its way into furniture (high-gloss kitchens and bath wares), vehicles that are produced in relatively small series (e.g. exterior and interior parts for agricultural, utility and recreational vehicles, and license-free cars), buses (interiors), trucks (interiors and exteriors), automotive (interiors and, to a limited extent, exteriors), sanitary wares, advertisement boards, luggage, and doors. The majority of the sheets that go into these applications are coextruded with polymethylmethacrylate (PMMA). Edge bands and profiles are often mono-layer extruded. In North America, customers frequently utilize MAGNUM ABS in extrusion applications that demand whiter base color, outstanding process consistency and low gel levels.
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ABS SHEET EXTRUSION

Primary and Secondary Plastics Processes

There is some complexity in the channel-to-market of ABS sheet extrusion. The sheet extruder does not supply directly to the brand owner, but to a thermoformer or rarely does the thermoforming themselves. The transformation from granules to end products goes through two different plastics processes, which have their own necessary ABS resin attributes: the primary process is sheet extrusion and the secondary process is thermoforming. The majority of all extruded sheet is thermoformed. The thermoformed parts go to the brand owner who does the final assembly into the end product, and sells the end product either directly to the end user or through a retailer.

A similar channel-to-market exists for edge bands and films for furniture. Extrusion of the edge bands and films is also the primary process. The extruders supply the edge bands and films to furniture manufacturers, who apply secondary processes of bending, lamination and gluing of the edge bands and films onto wooden boards, which are sold to retail shops as full furniture cupboards, or to distributors as furniture panels for “do it yourself” items, before they end up at the consumer.

ABS Resin Attributes

The primary (extrusion) and secondary (thermoforming, bending, lamination and gluing) processes require specific attributes from the ABS resins. Sheets and edge bands are offered in a very wide range of colors, making easy and efficient self-coloring important attributes of the ABS. A low base color and a good lot-to-lot consistency will improve coloring efficiency and will avoid color dosing corrections, enhancing productivity and reducing scrap. Side trim and other clean post-industrial scrap like off grade sheets are re-grinded and re-used during extrusion. Therefore, good thermal stability with retention of color and properties is important. All ABS resins yellow under solar exposure, but some types yellow less, requiring less UV absorber to maintain part color perception and potentially reducing costs. Surface quality of thermoformed parts is critical, and the number of surface defects should be minimal. Consequently, the number of unmelts (so-called ‘gels’ in the ABS) should be minimal as well. Purer ABS with low levels of volatile organic compounds (VOCs) will result in purer and cleaner surfaces after extrusion, with improved adhesion properties for lamination and gluing processes. Purer ABS products with fewer VOCs will also cause less odor nuisance for the operators, as well as for the consumers.

MAGNUM™ ABS VS. EMULSION ABS

There are two main methods for commercial production of ABS: solution polymerization and emulsion polymerization. The first is also called mass polymerization. The industry typically labels these as mass ABS (mABS) and emulsion ABS (eABS). MAGNUM™ ABS is produced using the mass polymerization process. Although most of the ABS worldwide is produced through the emulsion process, the mass process has a number of advantages that are described in this chapter.

In the emulsion process (1), first, rubber latex is produced by means of emulsifiers, followed by the polymerization of styrene and acrylonitrile in the presence of the rubber latex. Part of the polymerized styrene-acrylonitrile is grafted onto the rubber. This grafted rubber concentrate (GRC) is then either mixed with additional emulsion-prepared styrene-co-acrylonitrile (SAN) copolymer and then coagulated, or first isolated and then compounded with SAN. The emulsion process is a batch type of process, offering greater production flexibility.

In the mass process (1), rubber is dissolved in a mixture of the monomers styrene and acrylonitrile and a solvent. This solution is pumped into the first reactor in a series of reactors that are interconnected. The polymerization starts in this first reactor by increasing the temperature in the presence of an initiator, and continues further downstream until completion in the last reactor. The final step is the removal of residual monomer and solvent. The mass process is a continuous type of process, and has somewhat less production flexibility.

The advantages of the mass process are the absence of impurities like emulsifiers, leading to a cleaner and purer ABS product, and by virtue of being a continuous process, also leading to better lot-to-lot consistency, as well as improved rubber efficiency, making MAGNUM™ ABS less sensitive to rubber degradation processes.

The rubber phase morphology of MAGNUM™ ABS is different to that of eABS. Figure 1 shows a transmission electronic microscopy picture of cross sections of granules of MAGNUM™ ABS and eABS. The light gray phase in the pictures is the SAN phase. The dark gray phases are is the rubber particles. MAGNUM™ ABS has larger and occlude rubber particles, whereas the eABS has smaller particles.
with hardly any occlusions. Therefore, the MAGNUM™ ABS rubber particle morphology is characterized by a high rubber efficiency.

Figure 1: Rubber particle morphology of MAGNUM™ ABS vs. a high-impact eABS

Trinseo offers a wide range of ABS grades globally and four standard ABS grades from the new Zhangjiagang plant. The impact/flow chart (Figure 2) gives an overview of impact and flow balance of 4 of the most widely used Magnum ABS grades. The charpy impact was measured according to ISO 179-1/1eA and the melt flow rate according to ISO 1133 at 220°C and 10 kg. There are two low-flow grades designed especially for extrusion (MAGNUM™ 3904 and 3404), one medium-flow grade suitable for both extrusion and injection molding (MAGNUM™ 3513) and one high-flow grade designed for injection molding (MAGNUM™ 8391). MAGNUM™ 3904 is the high-impact grade, whereas the three other grades are so-called medium-impact grades.

Improved Lot-to-lot Consistency

Due to the nature of mass polymerization, the run sizes of MAGNUM™ ABS can exceed 1000 MT, ensuring a very high lot-to-lot consistency within such a campaign. In emulsion polymerization processes, run sizes are generally smaller. With MAGNUM™ ABS, customers usually receive multiple shipments from the same production campaign, which avoids the need to make adjustments in color masterbatch dosing or extrusion process settings, and potentially reducing the amount of extrusion scrap.

Table 1 shows the cost differences for coloring with a WMB, based on a price of 2.9 US$/kg for TiO2. eABS is 116 US$/MT more expensive to color. In addition, the increase in WMB (to achieve the same b* value) reduced the practical impact performance by 15%, here measured as an instrumented dart impact according to ISO 6603-2. In addition, the part density increased by about 9%, which goes against trend of light weighting in cars and recreational and utility vehicles.

![Figure 2: Impact/flow chart of MAGNUM™ ABS grades](image)

**Whiter Base Color**

The base color of MAGNUM™ granules is much whiter than eABS granules, which look somewhat yellow (Figure 3). Consequently, coloring (especially of whiter colors) may be easier and cheaper with MAGNUM™. Figure 4 shows how adding 4% of white masterbatch (WMB), containing 50% of titanium dioxide (TiO2) to MAGNUM™ leads to a 2.5 units lower b* value, compared with eABS. A lower b* value means a less yellow appearance. To reach the same b* value with the eABS, the amount of WMB has to be increased to 12%. The color data was measured on a Data Color Spectraflash SF600 PLUC-CT in reflection mode and illuminant/observer of D65/10°.

One may use an optical brightener (OB) to reduce yellowness. Optical brighteners emit blue light when exposed to ultraviolet (UV) light and may compensate for such yellowness. However, these OBs lose their blue-emitting effects over time. The rate of decrease is dependent of the amount and time of exposure to UV light. Figure 5 demonstrates that the eABS with 4% WMB and OB remains significantly more yellow than MAGNUM™ without OB. The relative b* value difference of eABS with OB vs. MAGNUM™ with OB does not improve.

Table 1 shows the cost differences for coloring with a WMB, based on a price of 2.9 US$/kg for TiO2. eABS is 116 US$/MT more expensive to color. In addition, the increase in WMB (to achieve the same b* value) reduced the practical impact performance by 15%, here measured as an instrumented dart impact according to ISO 6603-2. In addition, the part density increased by about 9%, which goes against trend of light weighting in cars and recreational and utility vehicles.
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High dosing levels of TiO2 may cause surface defects in sheets and thermoformed parts. High pigment loadings increase the risk of pigment agglomerates due to dispersion issues. Figure 6 shows an electronic microscopy picture of a cross section of an ABS sheet, where the agglomerate is visible just under the sheet surface, creating a surface defect. Element analysis shows the agglomerate mainly consists of TiO2. The element chromium (Cr) is related to the special surface treatment of the sample, which is necessary for the electron microscopy.

In extrusion, it is common to process regrind. Regrind is collected from shredding the side trim of extruded sheets and shredding scrap sheets, edge bands or profiles from the startup and shutdown production runs. Each time ABS is reprocessed, a color shift may occur due to the repetitive thermal load on the plastic. Therefore, an adequate thermal stability of the ABS is required to limit these shifts in properties. In essence, regrind is composed of ABS plastic that has been extruded once, twice, and three times, etc. respectively in ever-smaller fractions. In multilayer sheets, the regrind can be embedded in a core layer and color shift may not that critical. However, for mono-layer sheet applications, extra use of color masterbatch may be necessary to mask the effects of the regrind, which may lead to increased cost and reduced impact performance.

Figure 7 displays a picture of a reprocessing experiment. Both MAGNUM™ and eABS were reprocessed six times on a small twin-screw compounder. Glass vials sorted from left to right, with increasing numbers of regrind passes, show the color shift. The color of MAGNUM™ after six passes is visually lighter than the start color of the neat eABS. After six passes, the latter has shifted more in color, especially toward red, as shown by a substantial shift in the a* value (Figure 8). The a* value is expressed as a numerical value measured under reflective mode, and represents a color number along the green-to-red axis.
depth of embrittlement is a function of the amount of UV exposure.

Figure 9 also shows an infrared spectrum of the ABS before and after UV exposure. One can see an extra peak at 1725 cm\(^{-1}\), which is typical for a carbonyl functionality (C=O), and is due to photodegradation of SAN (2). The broad peak between 3200 and 3500 is N-H stretching vibration for amides, which are formed during photodegradation of SAN (2). Photo degradation of SAN causes the formation of yellow color bodies and chain scission, leading to reduction of the SAN's molecular weight.

In the following paragraphs, results of accelerated UV exposure tests of MAGNUM™ and eABS are discussed. To simulate indoor conditions, so-called QUV-A tests are used, whereas QUV-B tests are used to simulate outdoor conditions. The QUV-A test uses lamps radiating with 340 nm wave length and a cycle of eight hours' UV exposure with a 60 °C black panel temperature, followed by four hours' condensation with a 50 °C black panel temperature. The energy exposure is 0.77 W/m\(^2\). The QUV-B test uses lamps radiating with 313 nm wave length and a cycle of four hours’ UV exposure with a 60 °C black panel temperature, followed by four hours’ condensation with a 50 °C black panel temperature. The energy exposure is 0.63 W/m\(^2\). The color data was measured on a Data Color Spectraflash SF600 PLUC-CT in reflection mode and illuminant/observer of D65/10°.

Figures 10 and 11 respectively show the evolution of the b* value and delta E* values, after exposure to a QUV-A-accelerated weathering test. Both MAGNUM™ and eABS were loaded with 4% WMB. After 300 hours, the b* value of eABS is about 80% higher than MAGNUM™. The delta E* value is a numerical value that expresses the total color change vs. the original color before submission to the test. One can conclude that the eABS color ages twice as fast as the MAGNUM™. Theoretically, this means that MAGNUM™ needs around half the amount of UV absorber compared with eABS for indoor exposure conditions, which would represent significant cost savings.

Figures 12 and 13 indicate the evolution of the b* value and delta E* value after submission to a QUV-B test. After 300 hours of exposure, the eABS has a 26% higher b* value than MAGNUM™. The delta E* values show that aging is faster for eABS vs. MAGNUM™. In this case, one can theoretically reduce the amount of UV absorber by about 30% when loading the UV absorber into the bulk of the
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ABS sheet. However, it is more cost-effective for outdoor applications to put a relatively high amount of UV absorber into a cap layer of PMMA or acrylonitrile-styrene-acrylate (ASA).

Note that specific accelerated weathering testing is recommended to determine the adequate amount and type(s) of UV absorbing, and/or light stabilizing additives, for the actual application.

**Low in Unmelts**

Unmelts in ABS, also called gels, can cause aesthetic surface defects because gels do not melt during extrusion and may form a surface irregularity. Such irregularities are especially noticeable in cases where a high-gloss acrylic cap layer is coextruded.

In relatively thick sheets, these unmelts not usually visible after extrusion, unless they are located very close to the surface of the sheet (Figure 14). However, when thermoforming the sheets into a three-dimensional part, the wall thickness of the final part may become a lot thinner than the original sheet thickness. Consequently, unmelts that were not visible after extrusion become visible as optical surface defects in the end product.

![Figure 9: Degradation of ABS due to UV light exposure](image)

**Figure 9:** Degradation of ABS due to UV light exposure

![Figure 10: Accelerated QUV-A weathering test; b* evolution vs. exposure time](image)

**Figure 10:** Accelerated QUV-A weathering test; b* evolution vs. exposure time

![Figure 11: Accelerated QUV-A weathering test; delta E* evolution vs. exposure time](image)

**Figure 11:** Accelerated QUV-A weathering test; delta E* evolution vs. exposure time (dashed line depicts faster discoloration of eABS)

![Figure 12: Accelerated QUV-B weathering test; b* evolution vs. exposure time](image)

**Figure 12:** Accelerated QUV-B weathering test; b* evolution vs. exposure time

![Figure 13: Accelerated QUV-B weathering test; delta E* evolution vs. exposure time](image)

**Figure 13:** Accelerated QUV-B weathering test; delta E* evolution vs. exposure time (dashed line depicts faster discoloration of eABS)

In an extruded film (Figure 14), the gels are more likely to be visible after extrusion as it is already thin, and they become even more visible after thermoforming. ABS films are used in very demanding applications regarding surface aesthetics, such as automotive interior trims and furniture. The extruded film is cut to size, formed, and back injection molded into decorative parts for automotive, or cut to size and glued onto wooden boards in the case of furniture.
Figure 14 shows how a gel positioned close to the surface of an extruded sheet causes an aesthetic surface defect. The picture on the left side is a top view of the sheet surface, while the image on the right is the cross section microscopy picture of the sheet through the gel. This shows the location gel just underneath the sheet surface, as well as the deformation of the surface.

The next series of graphs depict a comparison in the amount of gels in MAGNUM™ vs. several eABS grades, counted and categorized by means of a Trinseo internal method. Two different and relatively large gel size categories are looked at in particular, referred to as “medium” and “large” gels. These are the gel size categories that are more likely to be visible to the consumers in the end application. Smaller gel size categories are critical for the most demanding applications. For those, Trinseo offers special low and ultra-low gel grades that can be imported from Europe.

Figures 16 and 17 indicate that there are significantly less medium- and large-size gels detected in MAGNUM™ compared with various commercial eABS grades available in China. Therefore, the risk for aesthetic surface defects in extruded and thermoformed parts is higher with these tested.

**A Purer Product**

The purity of ABS can be evaluated by means of differential scanning calorimetry (DSC) and by measuring the amount of volatile organic compounds (VOCs). Figures 18 and 19 show DSC plots of MAGNUM™ and eABS over a temperature range of 20 to 250 °C. MAGNUM™ has only one change at about 105 °C, representing the melting of the SAN matrix. Note that the changeover of the rubber phase happens at sub-zero temperatures. eABS has, in addition to the SAN change at about 108 °C, three changeovers at around 45, 70 and 128 °C. These additional changeovers can be referred to as impurities, as they are not SAN. These impurities may be emulsifiers, waxes or mold release agents. Mold release agents may be intentionally added, but they are not generally beneficial in an extrusion process. The presence of emulsifiers is inherently related to the emulsion ABS production process, whereas MAGNUM™ mass processes are free of such impurities. DSC is not a quantitative method, but one can generally state that the weight % of these impurities needs to be about 1% or more to become visible in DSC. Impurities can plate out on the die or on the roll stack,
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which have to be manually removed at regular intervals, causing production loss and adding cost.

Purity of ABS can also be expressed by the amount of VOCs. The higher the amount of VOCs, the less pure the ABS. These VOCs may cause an unpleasant smell during extrusion of the ABS, and the end consumer can also be exposed to unpleasant odors in cases of indoor applications such as automotive, truck and vehicle interior trims, and furniture. Figure 20 shows a comparison of measured VOC levels in various eABS vs. MAGNUM™. The VOC level is expressed as microgram total carbon emission per gram ABS, and was determined by means of headspace gas chromatography using a flame ionization detector. The measured levels of VOCs in eABS are substantially higher than in MAGNUM™.

CONCLUSION

In this study, a high-impact MAGNUM™ ABS was compared with a high-impact emulsion ABS, and other emulsion ABS grades. The results exposed the following advantages of MAGNUM™ ABS over typical emulsion ABS resins:

MAGNUM™ ABS has substantially less yellow in its base color.

- MAGNUM™ ABS stays more color-neutral after reprocessing.
- Upon exposure to UV radiation, white-colored MAGNUM™ ABS retains greater color stability.
- The number of unmelts or gels in MAGNUM™ ABS is substantially lower.
- The amount of VOCs in MAGNUM™ ABS was considerably lower.

In practical terms, the whiter base color of MAGNUM™ ABS substantially reduces pigment cost – especially when seeking lighter, brighter shades. Due to better thermal stability, MAGNUM™ ABS reduces color corrections when reprocessing as regrind. When exposed to UV radiation, white-colored MAGNUM™ ABS reveals a slower rate of discoloration, which may reduce the cost of UV absorbers. The considerably lower amount of medium and large gels in MAGNUM™ ABS reduces the risk for aesthetic surface defects of high-gloss thermoformed parts. MAGNUM™ ABS is also a purer product, with significantly less VOCs. Through choosing MAGNUM™ ABS, extrusion customers
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INTRODUCTION

Over the past decade, the National Association for PET Container Resources (NAPCOR) has worked with stakeholders to facilitate the collection and recycling of PET thermoform packaging—the clamshells, cups, tubs, lids, boxes, trays, egg cartons and similar rigid, non-bottle packaging made of the plastic resin with the resin identification code #1 - polyethylene terephthalate (PET). The effort has involved the full value chain: PET thermoform package manufacturers and converters; operators of material recovery facilities (MRFs); reclaimers; and end users of recycled PET (RPET).

Since the 1990s, postconsumer RPET has been used as a raw material feedstock in PET thermoforms for both food and non-food packaging. Over the past five years, the number of PET thermoforms recycled has continued to grow. In 2018, according to the NAPCOR 2018 PET Recycling Report, the U.S. and Canada recycled 139 million pounds of PET thermoform packaging, a 60 percent increase over 2017. Most reclaimers that purchase curbside PET bales in the US and Canada will accept, and process for next use, some percentage of thermoforms in their PET bottle bales.

BACKGROUND

In 2007, NAPCOR expanded its membership base from exclusively PET bottle and resin manufacturers, and suppliers to those industries, to include PET sheet and thermoform packaging manufacturers and converters. As of 2020, thermoform and sheet members include Dart Container Corporation, Direct Pack, Inc., Evertis Packaging Solutions, Klockner Pentaplast of America, Inc., OCTAL Extrusion Corporation, Plastic Ingenuity, Inc., POLAR PAK Company, and Sonoco. With the support and direction from these members, NAPCOR set out to work strategically with other stakeholders toward the goal of making the recycling of PET thermoforms as easy as recycling bottles, without compromising the successful bottle recycling infrastructure.

NAPCOR facilitated trials utilizing PET thermoforms aimed at determining what technical or practical issues would need to be mitigated in processing this material.

Early trials focused on identifying potential issues with respect to contamination, color, intrinsic viscosity (IV), and other chemical or technical parameters. More recently, in 2018, thermoform-only bales were run through PET reclamation facilities to identify mechanical and other technical concerns potentially caused by thermoforms’ lighter weights and varying shapes and sizes. The material sourced for this trial was obtained through MRF operators in the US who utilize optical sortation equipment.

NAPCOR ACTIVITIES

NAPCOR has engaged with its members, colleagues in other associations, and stakeholders in the PET thermoform supply chain to address the issues identified above, and work toward its goal of making the recycling of PET thermoforms as viable as recycling PET bottles, without harming the bottle recycling infrastructure. Going forward, NAPCOR will focus efforts in the following areas:

Clean it up

Our work related to recycling PET bottles that began over three decades ago determined that designing labels for recyclability was a requirement, and we now find that labels are an outstanding barrier to thermoform recycling that must be addressed. The Association for Plastic Recyclers (APR) has published Design for Recyclability Guidelines® which have been widely adopted by the beverage and bottle community; however, labels used to market and sell thermoforms vary widely -- from paper-based to olefins. Use of APR-approved labels, adhesives and inks (including store applied UBC labeling) and development of applied internal produce pads and labels that can be easily removed must also be adopted within the thermoform packaging community and by brands. Moreover, since labeling often occurs after thermoform manufacturers have sold the packaging to retailers and bakeries, all stakeholders need to adopt responsible labeling practices. Standardization of labels applied at time of filling may...
have greater opportunities to make an impact versus those applied at a salad bar or deli counter.

Because PET thermoform converters rarely apply labels on their packaging, NAPCOR actively seeks to engage with other stakeholders who can help drive change within the PET thermoform community. Retailers and other trade associations will help us align and promote the importance of using recycling-friendly labels and inks.

Collect It

In today’s environment, with sharp focus on ways to reduce our carbon footprint, postconsumer RPET is an obvious choice to incorporate into both bottle and thermoform containers. NAPCOR projects a shortfall of postconsumer PET material in the future, based on existing supply and public commitments to increase RPET content by leading beverage brands. Postconsumer PET thermoform material will be required to help address this shortfall, as demand for RPET rises.

Advancements in robotics have improved sortation of PET thermoforms. We need to establish conversations with industry leaders in this area to fully understand potential.

We’ll use it!

While postconsumer RPET from thermoforms may not be suitable for every application, we know of markets that are well-suited. This includes thermoform-to- thermoform applications as well as the fiber end market.

As consumer brands continue their path to incorporate more RPET content in their bottles and containers, the supply of RPET simply will not keep up with demand (NAPCOR, 2018 PET Recycling Report). From 2017 to 2018, the amount of PET thermoforms recovered in the US and Canada increased by 60 percent to 139 million pounds as referenced in chart below, and we anticipate continued growth.

Thermoform Recovery in the US & Canada

Future technological developments are in the pipeline, particularly with regard to MRF operations with rapid innovation in areas such as optical sortation and robotics. These advancements have the potential to improve sorting of PET thermoforms. This, along with other innovations such as enhanced recycling may make PET thermoforms more usable with bottle flake.

TRACKING TRENDS & PROGRESS

NAPCOR has worked to collect data on PET thermoform recycling, and to integrate PET thermoforms into NAPCOR’s efforts to understand PET recycling. As such, NAPCOR has reported on PET thermoform recycling in the US and Canada annually since its 2009 Report on Postconsumer PET Container Recycling Activity, now part of our PET Recycling Report. NAPCOR has documented a significant increase in PET Thermoform recycling in recent years, from about 45 million pounds in 2011 (the first year of published data) to more than 100 million pounds in 2014, and 139 million pounds in 2018. Furthermore, since 2009 NAPCOR has tracked the presence of PET thermoforms in postconsumer PET bales through its annual bale audits. The data indicates an average of less than 2 percent thermoform content in curbside PET bales in 2009, increasing to an average of 9.6 percent in 2019.

RPET Usage in US/Canada End Markets |
The SPE Thermoforming Division has announced a call for nominations for the Thermoformer of the Year Award. The award recognizes an individual who has made a significant contribution to the thermoforming industry in a technical, educational or managerial capacity.

The nomination deadline is March 31, 2021. Download the nomination form at https://bit.ly/2Jn4cKP. Nominations will be evaluated by the SPE Thermoforming Division Board of Directors during the Spring board meeting in May.

The 2021 Thermoformer of the Year will be recognized at the awards dinner held during the 28th Annual SPE Thermoforming Conference®, which will take place September 20-22 at DeVos Place and the JW Marriott Grand Rapids Hotel in Grand Rapids, Michigan. The awards dinner will be held on September 21 at the hotel.

Questions? Contact:
Juliet Goff
SPE Thermoforming Division Awards Committee Chair
E: juliet@kal-plastics.com

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THERMOFORMER OF THE YEAR

The Awards Committee is now accepting nominations for the next THERMOFORMER OF THE YEAR. Please help us identify worthy candidates. **The deadline for submitting nominations is March 31, 2021.**

This prestigious honor will be awarded to a member of the industry who has made a significant contribution to the thermoforming industry in a technical, educational, or managerial aspect of thermoforming. Nominees will be evaluated and voted on by the SPE Thermoforming Division Board of Directors during the Spring Board Meeting.

Please complete the form below and include all biographical information.

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- Publications and patents (please attach list).
- Evaluation of the effect of this individual’s achievement on technology and progress of the plastics industry. (To support nomination, attach substantial documentation of these achievements.)
- Other significant accomplishments in the field of plastics.

Individual Submitting Nomination: ____________________________ Title: ________________________________

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**ALL NOMINATIONS MUST BE SIGNED.** Please submit nominations to:

Juliet Goff  
Kal Plastics  
2050 East 48th Street  
Vernon, CA 90058-2022  
323-581-6194, ext. 223  
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Society Round Up

By Conor Carlin, SPE Executive Board, VP Sustainability

The pandemic has forced many changes on us, but one area where business continues as usual is in the exchange of ideas, of knowledge and networking within the global SPE community. Over the past quarter, we have seen a plethora of webinars, events, and meetings covering a wide range of interests for SPE members. The following is a summary of notable items from recent months.

SPE is Glocal

Our colleagues in Australia and New Zealand have a reputation for being a large and dynamic group who consistently deliver high-quality content. 2020 is no different, with the recent close of “Plastics and the Circular Economy – The Virtual Edition” (November 16-20). This 4-day event featured speakers from the antipodes, Europe, SE Asia, and the US, with presentations that ranged from LDPE Recycling in Europe to New Plastics Economy commitments, to public policy in Australia and plastics legislation in California. Each day included 4-5 presentations and drew roughly 100 people per session. Kudos to Han Michel, Craig Benson, Hamed Ghajarnia, and the rest of the board for yet another successful event.

Collaboration Across the Nation

Thanks to SPE CEO Pat Farrey’s deep connections in the association management world, SPE was able to deliver a joint event with the Institute of Packaging Professionals (IOPP) in October. “Plastics in Food Packaging – The Virtual Edition” featured 2 days of presentations from both thought leaders in the consumer packaged goods (CPG) area and technical experts from extrusion, blow molding, and thermoforming sectors. Dr. Michael Okoroaofo, VP of Global Sustainability and Packaging Innovation for McCormick & Co. delivered an insightful keynote that addressed not only sustainability imperatives for a circular economy, but also how the digital transformation is affecting the future of retail shopping and therefore packaging design.

Be sure to check the events page on the SPE website to stay current on all programming, including ANTEC 2021.

Measuring What You Cannot Manage

The topic of life cycle assessments (LCA) is front and center of the plastics debate. We often see references to dozens of LCAs illustrating the environmental benefits of plastics vs. other materials such as paper, aluminum, or wood. Still, LCAs are not for the faint of heart. SPE members were able to take a deep-dive thanks to a webinar by Christoph Koffler of Sphera, a Chicago-based consulting firm with global reach that specializes in risk management software with a focus on environment, health, safety, and sustainability (EHS&S). Koffler stressed that LCAs are modeling exercises and are not predictive. They can calculate the potential impacts of environmental decisions, but they cannot predict outcomes. Still, they are helpful for decision-makers, especially when comparing two different materials. In other words, despite some shortcomings, LCAs allow practitioners the ability to compare apples to oranges. Log in with your SPE credentials to access a recording of the webinar.

Be sure to check the events page on the SPE website to stay current on all programming, including ANTEC 2021.
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