Injection Molding Division
Molding Views

Winter 2024 | No. 123 www.injectionmoldingdivision.org Keep the connection! Join us on:

Chair's Message David Kusuma, Ph.D.

It's certainly an exciting time for the SPE. With the Winter Season now underway, this means the planning for the 2025 ANTEC is in full swing, and our very talented team of IMD leaders are working hard to create new value for our division and for the greater SPE.

The key highlights for our Injection Molding Division at ANTEC include the following:

Paper Sessions

Led by our Technical Program Chair, Davide Masato, the IMD TPC committee has reviewed and accepted papers for 3 full technical sessions at ANTEC. We invite you to join and listen to excellent presentations which highlight the latest in research and technology coming out of education and the injection molding field.

Reception

Led by our IMD Reception Chair, Tom Giovannetti, and after a hiatus of several years due to COVID and other factors, the IMD reception will be making a come back. We are very grateful to AutoDesk, which has generously provided sponsorship for this event. The IMD reception has long been one of the Crown Jewels in the ANTEC program, and we invite you to again join us to enjoy the evening and strengthen our community. There will be opportunities for networking and awards, including a recognition of the "best paper" IMD award selected by our division jurors.

IMPACT Part Competition for Injection Molding Excellence

I'm so excited for the IMD to be working with the SPE national team to develop a new part design competition for injection molding excellence, an event which was recently announced by SPE. I hope our members will take the opportunity to showcase your innovative and ground-breaking work! The finalists of this competition will be showcased at the ANTEC, and will be featured

IN THIS ISSUE:

in plastics industry publications both nationally and internationally. It's a great opportunity to be widely recognized for the amazing work which comes out of our industry and our intention is to make this a premium annual global competition for injection molding excellence.

Other than our immediate work for ANTEC, the division officers and IMD board are continuing to work to overcome some of our immediate divisional challenges. These include:

Membership

Led by Erik Foltz, our membership committee is looking for input and opportunities to reverse a declining membership. Ever since the SPE made Section and Division membership voluntary, membership numbers in the IMD have been challenging. Even though many SPE members are associated with injection molding, they don't participate in IMD events, nor see the value in joining. We hope to reverse this trend by creating new programs to bring renewed interest.

Programming

Earlier this year we completed our annual event titled, "Week of Injection Molding." The event featured excellent and notable speakers focused on both plastics technology and sustainability. Unfortunately even with advanced planning and additional promotion by the SPE national office we ended with only half the attendance we were expecting. It will be important moving forward that we are able to energize our membership for better participation to make the events worth the effort.

Communication

One of our top priorities for this term is to focus on our member communications. This means working to maximize our use of the IMD newsletter and website for better outreach. Not necessarily to upgrade these tools, but to make a better effort to increase readership, external connections, and engagements. Communication is the key to maintaining and increasing our membership, and we will look at optimizing this potential.

As you can read, there are a number of committees committed to serving our IMD members and ongoing SPE initiatives. If you have any interest to join and participate in any of our committees, we are always looking for excited and engaged volunteers.

To close, I want to mention that we are very proud to read the SPE's new board announcement where our own IMD board member, Lynzie Nebel, has been elected as President-Elect of SPE! We are very excited to transition into the new year and look to make 2025 into a very productive and memorable year for the SPE Injection Molding Division!

Merry Christmas, season's greetings, and best wishes to everyone during this special time of year!

David Kusuma
Chair, SPE Injection Molding Division

JANUARY 2025

SPE WORKSHOP: TROUBLESHOOTING IN INJECTION MOLDING

MONDAY, JANUARY 27, 2025 - THURSDAY, JANUARY 30, 2025 - ALL DAY

ONLINE

The injection molding process can seem complex with countless adjustments that will determine whether a process can produce an acceptable part. Organizations are struggling to find and train technical staff with the ability to problem solve. This workshop will aim to help organizations and their staff understand how to effectively resolve issues in the injection molding process. The benefits of effective and methodical troubleshooting can include reduced downtime, increased efficiency, reduced scrap and nonconformances, and improved quality. The workshop will focus on troubleshooting in two primary areas of the injection molding process. The first being the new mold build. Defining and addressing potential issues before a mold is released into production can lead to an efficient and successful tool launch. Using strategic tools, like process development and design of experiments, can determine what outputs achieve critical to quality criteria. The second focus will concentrate on the production aspect of the molding process. These are issues that arise on molds and processes that are already in production. Here we will focus on the 5 M's (Man, Material, Mold, Method, and Machine) of troubleshooting which will help rectify downtime and defects. This strategic approach will teach staff how to identify the root cause quickly, establish a fix for the issue, and create preventative measures so the problems no longer arise.

For more information: https://www.4spe.org/i4a/pages/index.cfm?pageID=9144

FEBRUARY 2025

SPE WEBINAR: THE CHALLENGES OF PLASTICS TESTING

TUESDAY, FEBRUARY 11, 2025 11:00 AM (EST) - 12:00 PM (EST)

ONLINE

While the plastics industry is constantly evolving, the importance of accurate, repeatable, and efficient mechanical testing continues to remain critical for supporting innovation and ensuring product quality. In this webinar, we will discuss the top mechanical testing challenges for plastics and ways to optimize your testing to improve results.

Learning Objectives:

- Overview of recent changes in key ASTM/ISO testing standards
- Factors that influence test results – solutions and troubleshooting tips
- How to increase laboratory efficiency to improve test times

For more information: https://www.4spe.org/i4a/pages/index.cfm?pageID=9003

2025 SPE INTERNATIONAL POLYOLEFINS CONFERENCE

SUNDAY, FEBRUARY 16, 2025 - WEDNESDAY, FEBRUARY 19, 2025

GALVESTON ISLAND CONVENTION CENTER, GALVESTON, TX

Co-Hosted by the following SPE Chapters: SPE South Texas Section, SPE Applied Rheology Division, SPE Building and Infrastructure Division, SPE Engineering Properties and Structure Division, SPE Flexible Packaging Division, SPE Polymer Modifiers and Additives and SPE Thermoplastic Materials and Foams Division.

For more information: https://spe-stx.org/international-polyolefins-conference-3/

MARCH 2025

ANTEC® 2025

MONDAY, MARCH 3, 2025 - THURSDAY, MARCH 6, 2025 - ALL DAY

SHERATON PHILADELPHIA DOWNTOWN, 201 NORTH 17TH STREET, PHILADELPHIA, PA 19103

ANTEC® 2025, SPE's Annual Technical Conference, showcases the latest advances in industrial, laboratory, academic, and international work focused on plastics and polymer science. ANTEC® will address a range of plastics technologies, polymer research, new materials, innovative processes, and more. There will also be a focus on scientific, technical, or industrial problems and their solutions.

For more information: https://www.4spe.org/i4a/pages/index.cfm?pageID=8878&utm_source=social_share&utm_medium=website&utm_campaign=ANTEC_2025&utm_id=ANTE_2025_Social_Share

SPE WORKSHOP: FAILURE IN PLASTICS

MONDAY, MARCH 17, 2025 11:00 AM (EDT) - WEDNESDAY, MARCH 26, 2025 1:00 PM (EDT)

ONLINE

This 4-part workshop series will cover a considerable range of topics important in understanding, diagnosing, and preventing plastic component failure. The most efficient and effective approach to plastic component failure is by performing a systematic failure analysis. Someone once said, "If you don't know how something broke, you can't fix it," highlighting the importance of a thorough understanding of how and why a product has failed. This workshop will cover information required to gain this understanding.

For more information: https://www.4spe.org/i4a/pages/index.cfm?pageID=8578

ANTEC® 2025

Sheraton Philadelphia Downtown
201 North 17th Street, Philadelphia, PA 19103

ANTEC® 2025, SPE's Annual Technical Conference, showcases the latest advances in industrial, laboratory, academic, and international work focused on plastics and polymer science. ANTEC® will address a range of plastics technologies, polymer research, new materials, innovative processes, and more. There will also be a focus on scientific, technical, or industrial problems and their solutions.

In addition to a comprehensive program, ANTEC® 2025 will offer exceptional networking opportunities, our prestigious SPE awards, symposiums, and our exclusive ANTEC® All-Access VIP Experience.

Sponsorship Opportunities Available!

ANTEC® 2025 is a 2.5 day in-person event with a cross-section of the plastics value chain topics on the latest advances in industrial, national laboratory and academic work. As an ANTEC® 2025 Sponsor, you will reach a global audience of plastics decision-makers at one of the leading plastics technology events.

Visti www.4spe.org for more information.

2024 SPE Injection Molding Division Scholarship

Thank you, SPE Injection Molding Division!

Daniela D'Alleva is currently pursuing a degree in Plastics Engineering at the University of Massachusetts Lowell. During her time at UMASS Lowell, she has been involved in several noteworthy projects related to plastics engineering. One such project involved designing a shoe charm featuring the university's mascot. Her team then created a mold of the charm, which was used in an injection molding machine to produce over 400 charms. These were showcased and distributed at the 2024 National Plastics Exposition. Daniela intends to pursue a Master's degree in plastics engineering and aspires to work in the sports industry. She hopes to utilize her expertise to enhance the safety of sports e9uipment for athletes of all ages and skill levels.

Thank you so much for awarding me with the SPE Injection Molding Division Scholarship. This generous scholarship will alleviate some of the financial burden that my college education has placed on my family. I was initially an undeclared engineering major until I attended a networking event where I spoke to two UMASS Lowell alumni who were plastics majors. That night, I decided to declare my major as plastics engineering, and I am so glad that I made that decision. I am on summer break and am itching to get back in the classroom to learn more about plastics. Again, thank you for your support!

Navigating the Future of Sustainable Plastics: 2025 and Beyond

By Tom Wood, ES Plastic Products, LLC

As global concerns about environmental impact intensify, the plastics industry is under increasing pressure to adopt sustainable practices. Historically, corporations and original equipment manufacturers (OEMs) have expressed interest in using recycled plastic content in their custom parts. However, these efforts have often been voluntary, and the industry has struggled to make significant progress. But with new legislation pending and approved across various states, using sustainable plastics is quickly transitioning from a corporate initiative to a legal requirement. For the injection molding industry, adapting to these changes while maintaining cost-effectiveness and quality is becoming a critical challenge.

The Push Toward Sustainable Plastics

For decades, the plastics industry has operated on the principle that virgin plastic resins derived from oil were inexpensive, effective, and reliable. OEMs, in turn, relied on injection molders to deliver high-performance parts at competitive prices. However, growing concerns over plastic waste, pollution, and climate change have led state and local governments to introduce stringent new regulations on plastic use, particularly in consumer goods like food and beverage packaging.

Currently, 10 states, including California, New York, and Washington, have enacted laws banning certain single-use plastics and other plastic materials from landfills. These regulations specifically target plastics in consumer products, aiming to reduce the volume of non- biodegradable materials that contribute to environmental pollution. As more states follow suit, corporations will no longer have the option to use unsustainable materials—they will be legally required to incorporate sustainable alternatives, such as post-consumer resins (PCR), into their products.

These regulatory changes have also been fueled by growing consumer sentiment. Increasingly, consumers are demanding that companies reduce their environmental impact, and businesses that fail to prioritize sustainability may face reputational damage and lost market share.

The Reality of Plastic Recycling: A Complex Challenge

While recycling seems like a simple solution, the reality of recycling plastics is far more complicated. According to a 2019 study, only 5% of all plastics were recycled, while 86% ended up in landfills. Although the desire to recycle plastics has increased, the inherent complexities of different plastic resins make recycling an expensive and difficult process.

Plastic resins are not all the same. There are seven distinct chemical platforms for plastics, each with its own molecular structure, performance characteristics and end-use applications.

This diversity makes sorting, cleaning and processing plastics into reusable materials a costly endeavor. Furthermore, the logistics of collecting, transporting, and reprocessing post-consumer plastics further increase costs. The result is that PCR often costs 20% to 50% more per pound than virgin resin, making it a less attractive option for cost-conscious manufacturers.

Beyond cost, recycled resins often suffer from compromised properties. Compared to virgin resins, recycled plastics may not meet the same mechanical, structural, or cosmetic requirements. For companies producing complex or high-performance parts, this can be a significant barrier to adopting sustainable materials.

The 2025 Challenge: Balancing Cost, Quality and Sustainability

By 2025, injection molders and OEMs will face the challenge of balancing the higher cost of sustainable resins with new regulatory requirements. For many years, OEMs have been hesitant to adopt sustainable plastics due to cost concerns. In many cases, the use of eco-friendly resins has been more of a marketing initiative than a genuine commitment to reducing environmental impact.

For injection molders, the pressure will come from both regulatory bodies and customers. OEMs will expect molders to comply with new laws while maintaining competitive pricing and product performance. However, the reality is that sustainable resins often come at a higher cost and may not always meet the strict performance standards required for certain applications. This creates a challenging dynamic where molders are expected to deliver environmentally friendly solutions without raising prices or sacrificing quality.

Despite these challenges, there is some optimism for the future. The gap between the cost of virgin and PCR resins is beginning to narrow as investments in sustainable plastic technology grow. Companies are exploring new ways to blend PCR with virgin materials to create hybrid resins that offer both environmental benefits and reliable performance. These hybrid resins could allow manufacturers to meet regulatory requirements without drastically increasing costs.

Innovations in Sustainable Plastics

The future of sustainable plastics will likely be shaped by innovations in both material science and manufacturing technology. One of the most promising developments is the rise of hybrid resins, which combine PCR with virgin materials to create a blend that offers the best of both worlds. These resins can reduce the amount of virgin material used, while still maintaining the mechanical properties necessary for high-performance applications.

In addition to hybrid resins, there is growing interest in plant-based bioplastics. Materials such as hemp and other natural resources are being explored as alternatives to traditional oil-based plastics. These bioplastics are not only environmentally friendly but also offer a favorable cost basis for manufacturers. As demand for sustainable materials increases, bioplastics could become a key component of the industry's transition to more eco-friendly solutions.

Another significant trend is the investment in sustainable plastics by major resin manufacturers. Large corporations such as Dow Chemical, BASF and Sabic are pivoting their research and development efforts toward sustainable materials. These companies are investing heavily in new technologies and facilities to create product lines focused on biodegradable, PCR and eco-friendly plastics. At the same time, new entrants to the market are building factories dedicated exclusively to producing sustainable resins, sensing the growing opportunity within the industry.

The Role of Legislation in Driving Change

Legislation will play a crucial role in shaping the future of sustainable plastics. As more states pass laws mandating the use of eco-friendly resins, OEMs will be forced to comply, and this pressure will trickle down to injection molders. By 2025, injection molders will likely see a sharp increase in requests from OEMs for carbon emission reports, green initiatives and the use of PCR in their products.

The closer the price gap between virgin and sustainable resins becomes, the smoother this transition will be. For now, many OEMs are still resistant to paying higher prices for sustainable materials. However, as regulations tighten and consumer demand for sustainability grows, this attitude is likely to shift.

The molding industry must prioritize research and development to meet these evolving demands. Offering cost-effective, high-performance solutions will be key to ensuring a smooth transition to sustainable materials. OEMs and molders alike will need to recognize the importance of collaboration and teamwork in achieving these environmental goals.

In Conclusion: Preparing for the Future of Sustainable Plastics

The plastics industry is at a critical turning point. As we approach 2025, the pressure to adopt sustainable materials will only intensify, driven by both legislation and consumer demand. For injection molders, the challenge will be to balance cost, quality and environmental responsibility while delivering solutions that meet both regulatory requirements and customer expectations.

At E-S Plastics, we are committed to staying ahead of these trends. Our focus on innovation, collaboration and sustainability allows us to offer our customers the most viable, cost-effective solutions in the evolving landscape of plastics manufacturing. As the industry moves toward a more sustainable future, we will continue to invest in new technologies and materials that reduce environmental impact without compromising performance.

The future of sustainable plastics is bright, but it will require continued effort and investment from all stakeholders. Together, we can create a future where plastics are not only functional and cost-effective but also environmentally responsible.

About the Author

Tom Wood is the Vice President of Sales and shareholder at E-S Plastic Products, LLC. Throughout his 30-year career in plastics, he has taken on the challenge to build or replace sales revenues several times. This experience led to having trust in the value of persistence, networking, and building strong relationships. He is passionate about formulating strategic plans for each business situation and opportunity. Tom's background includes 10 years working in a family-owned injection molding business, 14 years partnering in a Manufactures Rep business that specialized in plastic processing including Injection, Thermoset, Rotational, Extrusion, Vacuum Forming and Blow Molding and his current assignment at E-S Plastics. He began his current role at E-S Plastics in 2012.

Tom is a graduate from the Indiana University Kelley School of Business. For more information, he can be reached by phone at 262-534-5555 Extension 112, 414-588-8900 (Mobile Office) or by email twood@esplastics.com

Fisher-Tropsch Hydrocarbons as Processing Aides in Injection Molding

By Stefan de Goede, Sasol Chemicals, Germany
Steve Torchia and Justyn Miller, Sasol Chemicals, North America
Pieter van Helden and Jerrie Vermeulen, Sasol Chemicals, South Africa

Polymer producers and converters are continuously evaluating options to reduce costs by producing faster, reducing energy consumption, reducing scrap and improving finished article mechanical and aesthetic properties. Recently, however, sustainability and overall environmental impact have also become prominent themes for converters.

Processing aides are commonly used in blown film extrusion and injection molding. Specifically in injection molding silicone spray, fluoropolymers and oleochemicals are used. An alternative is to use higher molecular weight Fischer-Tropsch (FT) hydrocarbons as a polymer processing aide and mold release agent due to its good compatibility with the polymer compound matrix. Formulating with these hydrocarbons allows the converter to reduce cycle time, produce faster to reduce labor, to reduce energy consumption and improve certain properties of the injection molded article. Ultimately FT as a polymer processing aide could be an important tool to a converter to reduce manufacturing costs and improve quality.

Introduction

The plastics industry has contributed significantly to the world economy and is seen as essential in several durable and non-durable applications. Plastics have replaced several materials in numerous applications, and mostly provide a good combination of physical properties and cost. Injection molding is a significant part of the polymer conversion industry. Worldwide, the market was over $225 billion in 2016 [1]. It is thought that the global injection molding market may reach $340 billion in 2024 [2]. The main growth area appears to be the automotive sector. The electronics industry is also a rapidly growing segment [2].

Although plastic injection molding has undergone significant improvements over more than 70 years, there are still continuous efforts to minimize production costs. Cycle time improvement and reduction of the scrap rate can have a significant influence on the profitability of an injection molder. The lifetime of a typical injection molding machine is expected to be around 10 to 15 years [3]. While equipment is not frequently replaced, the replacement costs is generally high and a fast return on the investment can provide a competitive advantage. Similarly, many injection molding customers are looking at efficiency improvements that could be implemented without significant capital spend. Additives are, therefore, attractive as they can be implemented with relative ease and relatively low cost.

The paper will discuss the role of processing aides and then focus on the use of Fischer-Tropsch molecules as processing aides in the polyolefin injection molding process.

Processing Aides for Injection Molding

It is possible to distinguish between two types of additives that could improve efficiency during injection molding: processing aides and mold release agents. Mold release agents in polyolefin processing are typically silicones. However, in this section the focus will be on processing aides and their potential benefits during polyolefin injection molding.

Oleochemicals (including metal stearates), fluoropolymers, low molecular weight waxes and certain other oleochemicals can be used as processing aides in injection molding. Additives like glycerol monostearate, ethylene bis stearamide, alcohol ethoxylates and erucamide have been used in injection molding to improve processing [4]. Typically, these additives are added at low levels (< 0.2 %). Increasing the concentration to the levels required to act as a processing aid (>0.5 %), could have negative effects on downstream processing like printing and accumulation in water. Fluoropolymers are effective but expensive [5] and also under increased environmental scrutiny. Metal stearates and oleochemicals can, however, result in screw slip and deposit build-up, create organoleptic issues, degrade forming color issues, which are undesirable effects.

The oldest and most subtle form of process aide is the low molecular weight component of a polymer's molecular weight distribution. These short chain molecules typically improve flow, while, if added at low concentrations, do not result in a significant deterioration in the mechanical properties [4]. However, polyolefin resin production purposely eliminates low molecular weight fractions before addition of stabilization additives. These low molecular weight fractions can be added directly into the polymer and result in an improvement in the melt flow rate.

Fischer-Tropsch (FT) processing aides are structurally similar to the low molecular weight part of a polyethylene molecular weight distribution. Fischer-Tropsch process aides are also highly compatible with polypropylene and other polyolefins. FT have been used as processing aides in injection molding for more than 15 years [4]. Given the properties of these molecules, they are fully compatible with PP and PE resins, potentially eliminating some of the issues that could be experienced with the use of external materials like silicone or internal process aides like oleochemicals.

Fischer-Tropsch Processing Aides

Fischer-Tropsch Processing Aides (FTPA) are produced by the Fischer-Tropsch synthesis process [4]. The FT process converts coal or natural gas into hydrocarbon products. This process is well known for the production of fuels (diesel, gasoline) and also chemicals, and has been commercially used in South Africa since 1950 [6]. The first commercial wax from this process was introduced into the market in 1955.

During the first step of the process, natural gas is desulphurized and then fed into the reformer unit. This unit produces synthesis gas (syngas), consisting of hydrogen and carbon monoxide. Syngas is then converted in the process to on-purpose hydrocarbons. The hydrocarbons can be simply classified into a wide range of cuts yielding, paraffin, medium and high melting waxes. Properties such as the crystallinity, melting point, congealing point, needle penetration, and molecular weight distribution define the product outputs of the Fischer-Tropsch distillation process. These molecules can then be further hydrogenated or functionalized by oxidation, saponification, maleation, or addition of other functional groups .

The high-melt point FT Processing Aides have been used extensively in polymer processing, including injection molding [4], PVC processing [7,8], masterbatch manufacturing [9] and polyolefin extrusion [10]. Unlike thermally degraded waxes and byproduct PE waxes (BPPE), FT molecules are on-purpose produced and can be manufactured to very tight specifications, controlling very precise carbon chain distributions.

Properties	Fischer Tropsch Processing Aide	PE waxes
Drop melting point (°C)	115	101~106
Viscosity at 135 °C (cPs)	<10	>200
Molecular structure	Mostly linear	Branched
Molecular weight	600-1200	2000~12000

Table 1
Typical properties of FT Processing Aides commonly used for injection molding in comparison with PE waxes.

Table 1 shows the typical properties of the FTPA, used in this study. This FTPA has been in the market for more than 15 years, where the benefits have been shown in a variety of applications.

FTPA are typically significantly lower in molecular weight and viscosity compared to conventional PE waxes.

Although a comprehensive mechanism of the working of FTPA in this application has not been completely corroborated, it is typically deemed to show benefits by proceeding along the subsequent scheme: FTPA are fully soluble in the polymer matrix (being non-polar). Due to this compatibility and its mostly linear structure, it penetrates the polymer matrix and fill the free void volume. These FTPA allow the longer molecules to move more easily past or over each other, thereby lowering the viscosity (improved flow properties) of the mixture. This easier movement enables ease of processing, improved productivity and efficiency. In filled systems, the low surface energy assists in pigment/filler coating, thereby facilitating dispersion. These molecules have been shown to be effective in both low and high MFI polyolefins [4]. Potentially, these processing aides could enable the use of lower MFI polymers, with the added benefit of better physical properties. These processing aides are effective in both unfilled and filled formulations.

Laboratory studies: the effect of FT Processing Aides on PP injection molding

In the current study, the effect of FT Processing Aides on the viscosity, spiral flow and selected mechanical properties (tensile properties and impact properties) are shown.

Materials

In the first experiments, a commercial 8 MFI polypropylene homopolymer from Sasol Polymers was used. The polymer was filled with 11% $CaCO_3$. An Engel injection molding machine was used. For the three experiments, the following additives and levels of addition were used:

1. Calcium stearate: 0.75%
2. Commercial FT Processing Aide: 0.75%
3. Commercial FT Processing Aide: 1.76%

The addition of FTPA aides could be a potential benefit in terms of lowering the energy required for processing and the benefits will be discussed in the next sections.

Results

Rheology measurements were performed on an Anton Paar MCR parallel plate Rheometer. Experiments were conducted at 190 °C and at 230 °C. It is expected that both calcium stearate and the FT Processing Aide will reduce the melt viscosity. The results are presented in Figure 1.

From Figure 1 it is evident that over the shear range studied, calcium stearate and FTPA lowered the shear viscosity with the FTPA outperforming CaSt at equivalent loadings. Increasing the level of FTPA resulted in a further lowering of the viscosity. It is evident that FTPA can decrease the viscosity of the polymer, which will ease the injection step, enable faster chain relaxation, allows faster flow into the mold form, and faster flow through runners.

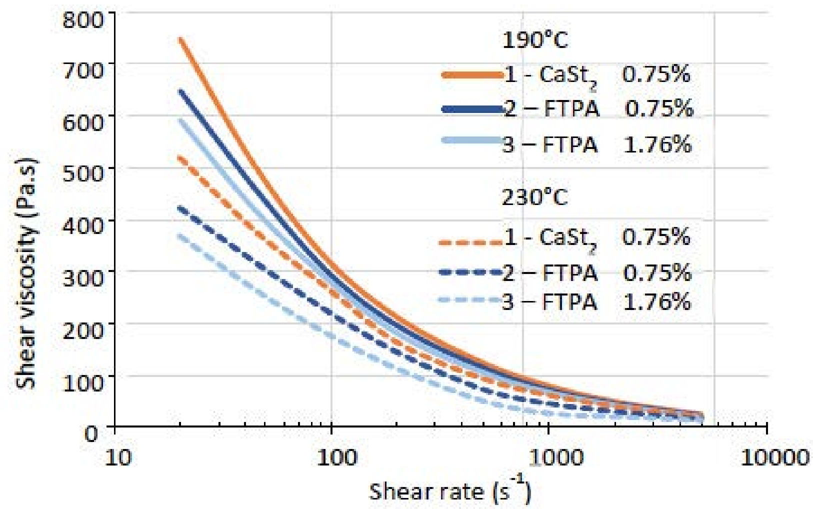

Figure 1. Viscosity effects of 1) CaSt, 2) FTPA at 0.75% and 3) FTPA at 1.76% in PP at two temperatures.

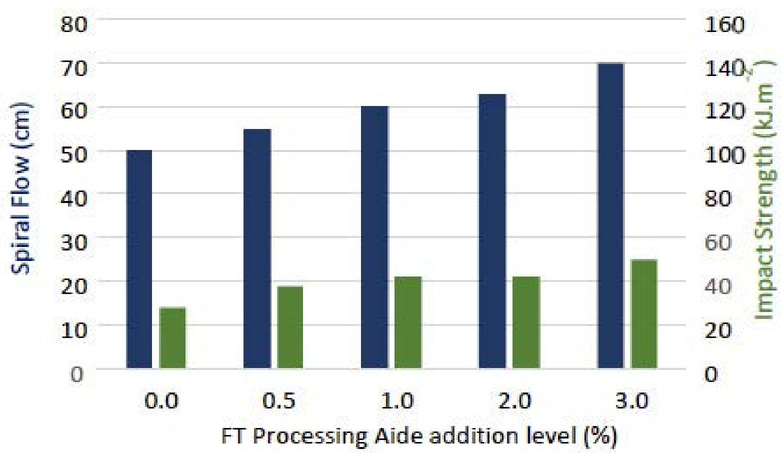

Figure 2. Effect of the FTPA on spiral flow and impact strength.

FTPA consist of chains that are shorter than the average chain length of the polymer that is being injection molded. It is therefore important to ensure that the addition of FTPA does not result in a deterioration of the mechanical properties. Laboratory testing was carried out to quantify these effects and to investigate if the addition of these processing aides could improve certain properties. Marshall [4] showed that the addition of these molecules (within a given range) did not result in a significant deterioration in the mechanical properties during injection molding. Although not discussed further there, it was noted that FTPA addition would not result in a deterioration in optical, adhesion and printability properties [4]. The present work covers additional test to highlight the effect of the addition of these molecules on the process.

In Figure 2, the effect of the FTPA on spiral flow and impact strength is shown. Spiral flow is an indication of the ease of flow - the longer the spiral flow (in cm), the better the flowability. With increasing FTPA addition levels an increase in the spiral flow was obtained. This is in line with the viscosity measurements (Figure 1). It is evident that there was a marginal improvement in the impact strength.

In Figure 3, the stress at break and stress at yield results are shown.

The results in Figure 3 indicates that the stress at break results were consistent up to 3% FTPA addition. Interestingly, the stress at yield showed an increase. Up to 3% addition the FT addition had no negative influences on the tensile properties, with even a slight benefit in the stress at yield performance.

In Figure 4, the effect of FTPA on the spiral flow and impact strength of different PP homopolymers (MFI= 8 and 12) and a block copolymer (MFI=5) is shown.

The results in Figure 4 indicate that the FTPA provided benefits in various formulations ranging from unfilled PP to filled PP, and to both homopolymers and copolymers.

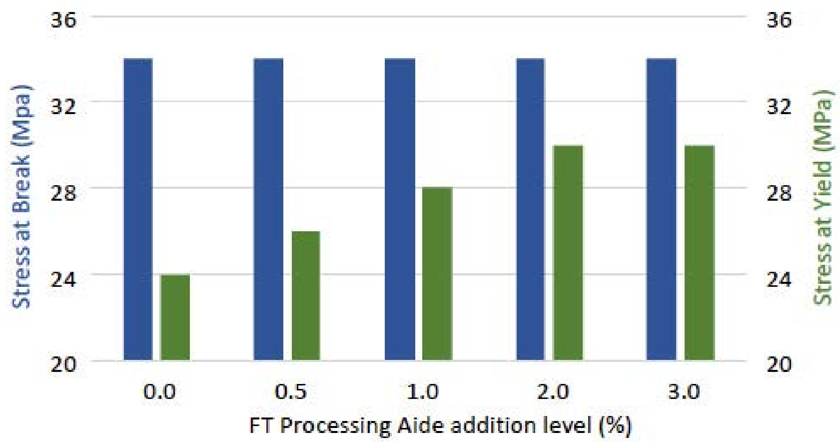

Figure 3. Effect of the FT Processing Aide on tensile properties

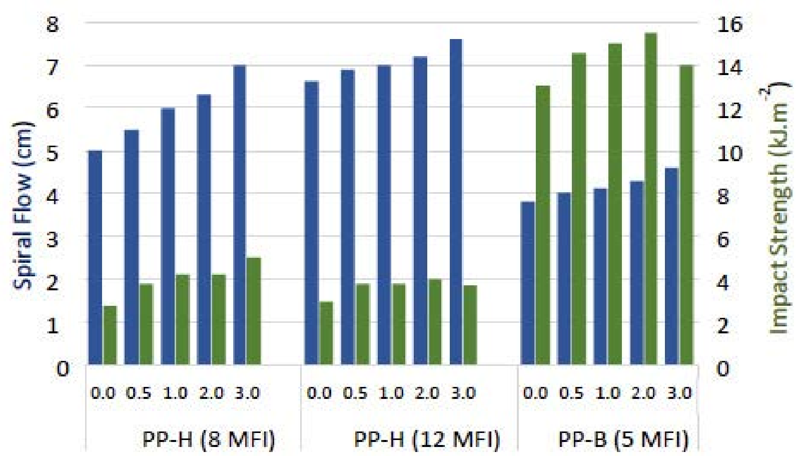

Figure 4. Effect of FT Processing Aide on two PP homopolymers (PP-H) and a block copolymer (PP-B)

Optimization needed when adding FT Processing Aide

The addition of FTPA may not immediately result in a process improvement and needs to be done together with optimizing the injection molding process. The typical addition rate of FTPA to PP is 1-2%, but in some cases up to 4% can be added. As a first step, it is important to understand if the process is plasticization or cooling limited. Should the process be plasticization limited, the effect should be carefully observed before and after the introduction of the FTPA. It is important to check if there is a drop in the plasticization time before dropping the backpressure. This can be carried out in steps. The screw speed can also be increased, if required. If the cycle is governed by cooling time, FTPA can also assist in optimizing the process. After the addition of a FTPA, it may be possible to decrease the temperatures in the extruder and mold to obtain a lower melt temperature. FTPA addition will result in a significant reduction in the melt viscosity. In Figure

5, the effect of the addition of FTPA on the viscosity of a 2MFI resin is shown as a function of temperature. It is clear that the effect of the FTPA is seen across the temperature range.

It is important to note that the addition of FTPA needs to be carried out correctly and the machine parameters to be set correctly. The processing aide (which is in a solid, pastille form) can be blended with the polymer using conventional techniques, such as tumble blending, or via dosing directly into the extruder via micro-feeders.

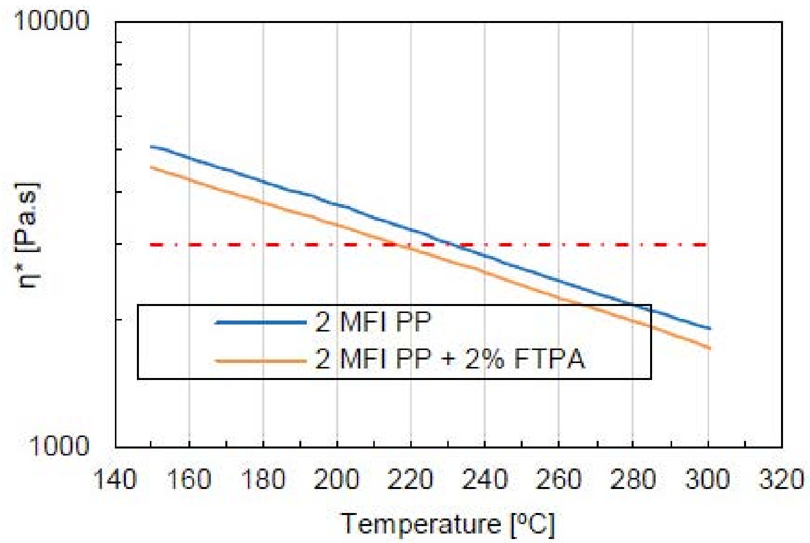

Figure 5. Effect of the addition of FTPA on melt viscosity. [4]

Summary of the outcome of the Laboratory Investigations

The main conclusions from the laboratory investigations and trials can be summarized as follows:

- FTPA acts as a viscosity modifier during the processing of polyolefins, allowing faster plasticization and quicker injection.
- The addition of FTPA allows for the use of lower temperature profiles and/or reduces cooling times. These factors ultimately result in faster cycle times during injection molding.
- Rates are typically increased by between 10% and 25%with no adverse effects on physical dimensions or mechanical properties of the molded articles.

Case Studies From the Field

In this section a number of cases of successful applications will be covered. It is evident that the FTPA could be used in both smaller and larger items to optimize the cycle times, to improve part quality, and address common in-process induced defects.

Parameter	Before FTPA Addition	Change after FTPA addition
Temp. Profile (°C)	200-220-220-220-210-200-185	↑15-↓10-↓15-↓20-↓15-↓10
Hot-runner (°C)	220-220-220-220-220-220-220-220-220	-
Cycle Time (s)	**130.5**	**↓27.1 (21%)**
Cooling Time (s)	**65**	**↓20 (26%)**
Back Pressure (%)	5-5-25	-
Screw Speed (%)	75	-
Melt Cushion (mm)	0.5	-
Injection Pressure (%)	60-70-70-65-60	↑5
Injection Time (s)	**18**	**↓7 (39%)**
Hold-on Pressure (%)	35-35	-
Holding time (s)	5	-
Injection Speed (%)	70-75-80-70-55	-
Plasticizing Time (s)	17.6	**↓1.6 (9%)**
Silicone Spray	every 4 shots	-
Part Ejection Temp. (°C)	50-70-46	marginal decrease
Part Weight (g)	3400	**↓15 (0.4%)**
Productivity (parts/hr)	**27**	**↑8 (30%)**

Table 2. Effect of FTPA on the number of bumpers produced

Case Study 1

In the first case study, the effect of the addition of FTPA on molding a car bumper was evaluated. The type and model number of the extruder was not disclosed. For this particular optimization the temperature profile was optimized by increasing the temperature in the first zone, while decreasing the temperatures in the other zones. The conditions and results are given in Table 2.

By careful optimization, it was possible to produce 8 extra bumpers per hour, which is a productivity improvement of around 30%. Further, take note that the average part weight was reduced due to improved part tolerances which saves material.

Case Study 2

In the second example, the effect of FTPA on beer crate production is shown. For this example, the customer was interested in maximizing output while maintaining the quality of the crates. The temperature profile was optimized (Table 3). The results are presented in Table 4.

In this case, the addition of FT Processing Aide resulted in a 17% overall improvement in productivity.

Before FTPA addition						
Temp. profile (°C)	Set	204	240	249	248	199
	Actual	204	239	249	248	193
After FTPA addition						
Temp. profile (°C)	Set	180	198	230	205	190
	Actual	183	207	228	210	189

Table 3. Temperature profiles with and without FT Processing Aide

PP used in the production of beer crates		
	Reference	2% FTPA
Cycle time (s)	62	53
Cooling time (s)	35	25
Plasticization time (s)	27	24
Parts per hour	58	67
Productivity improvement	17%	

Table 4. Improvement in cycle time by adding FTPA.

Case Study 3

FT Processing Aide has been extensively trialed in garden and home furniture. Table 5 summarizes some examples, plus the benefits that were gained.

The results indicate that over a range of chairs, the FT molecules were able to provide significant cycle time reductions, allow for lower temperature profiles, and reduced pressures.

Cost in use of FT Processing Aide in Injection Molding

A previous paper reviewed the financial benefits of the use of FT Processing Aide [4]. The injection molding industry is predominantly price sensitive, so any increase in production cost is closely scrutinized. Often costs are only considered to be input cost, be it raw materials or labor and utilities. It would, however, be better to consider unit cost to produce an article. A fair reflection would be to split the cost into 'machine cost' and 'material cost'. Although the additive may add cost to the 'material costs', the addition of FTPA could play a positive role in reducing the 'machine costs', be that by lowering electricity consumption or increasing output, thereby improving the productivity of the whole process.

In today's environment, overhead costs tend to exceed direct labor cost for injection molding operations. Internet searches for "injection molded part cost" or "injection molded part cost reduction" yields numerous articles with strategies to reduce unit cost. Clearly, faster cycle time is promoted and partly achieved through good mold and part design as well as screw design and cooling. Material selection and use of a polymer processing aide has been proven to yield substantially faster cycle times and lower energy requirements. Processing aides which reduce cycle times yield reduction of the overhead and direct labor cost per molded unit. Meanwhile, even an increase in material cost due to use of a process aide yields lower cost per molded part. Faster processing with lower energy requirements can dramatically reduce production time, reduce number of machines, reduce direct labor cost, and help spread plant overhead costs. In the following examples, the use of Fischer-Tropsch as a polyolefin process aide shows lower cost to produce a variety of polyolefin articles.

Polymer prices are as reported by Plastics News October 2020 [11]. HDPE Injection GP grade 76 cents/lb and PP Homo Injection GP grade 67 cents/lb. In Table 6, the potential cost saving per article for a few examples are shown.

Table 6. Potential savings obtained when using FT Processing Aide

Manufacturing cost assumptions; Direct Labor @ $20/hour, Electricity @ $0.08/kWh, faster production reduces operating days, plant base load for electricity unchanged.

In summary, FT Processing Aide can reduce direct processing costs, while also aiding in reducing overhead costs.

	Description	FTPA addition rate	Cycle time reduction	Processing changes	Other benefits
1	PP Garden Chair	+2%	11%	↓temp profile 20°C ↓back pressure 10% ↓cooling time 15%	Productivity ↑11%
2	PP Garden chair	+3%	19%	↓back pressure 60% ↓plasticizing time 22%	Productivity ↑23%
3	PP Garden chair	+4%	24%	↓temperature profile 10°C ↓back pressure 70% ↓plasticizing time 12% ↓cooling time 12%	Productivity ↑24%
4	PP household chair	+3%	10%	↓temp profile 30°C	-Lower injection pressure -Reduce silicon spray 60% -Productivity↑10 %
5	PP Household chair	+5%	9%	↓temp profile 20°C	-↓injection time 18% -↓hold time 18% -Eliminated silicon spray -Productivity↑9 %
6	PP Medium chair	+5%	8%	↓temp profile 5°C ↓cooling time 15%	-Improved pigment dispersion -↓injection pressure -Eliminated silicon spray -Productivity↑8 %

Table 5. Summary of other examples of efficiency improvements by using FT Processing Aide.

	Polymer	Article weight in grams	Initial Cycle Time	Cycle time with FTPA	% lower Cycle Time	Savings per article
Hinged closure	PP	12	11.8	10.2	-14%	5,34%
Hinged Container	PP	80	17.9	15.9	-11%	6.88%
Beverage Crate	HDPE	850	38	30	-21%	2.95%
Dairy crate	HDPE	1800	51	48	-6%	2.49%
12-bottle crate	HDPE	2100	57	50	-12%	2.86%
Table	PP	3000	109	85	-22%	4.94%
Fruit picking crate	HDPE	34000	156	130	-17%	3.82%

Table 6. Potential savings obtained when using FT Processing Aide .

How Can FT Processing Aides Aid in Sustainability?

The pressure on converters (and their customers) to be more sustainable is constantly increasing. Apart from recycling, there is also a drive to decrease the footprint from their processes. The ability to lower energy consumption and increase output rate could be used by converters to reduce their costs, and also have a positive effect on their environmental footprint. As shown in Table 5, this effect could be significant (productivity increases of more than 10% are typical). It is assumed that around 70% of the energy use of an injection molding machine is used for plasticization. The addition of FT molecules can, therefore, have a major influence on the energy consumption by allowing easier processing.

The reduction in scrap is also a potential environmental benefit that could be exploited. There is also the possibility to use a lower MFI polymer (with associated better mechanical properties), and then use the FT processing aide to improve the flow, thereby ensuring proper mold filling. These processing aides can also potentially be used to enable recycle content. Should the MFI of a recycle stream be too low, inconsistent, or containing polymer gels to be considered for injection molding, FTPA may aid the process.

Some additional benefits that were noted include:

- Improved mold release (compared to silicon sprays this results in a significant cost saving)
- FT Processing Aide can also be used to aid the dispersion of inorganic fillers, such as calcium carbonate, talc, etc., in polyolefins during compounding prior to injection molding.
- Easier de-molding may lead to faster cycle times
- Smoother surface finish and improved gloss
- Better pigment dispersion
- May enable reduction of the masterbatch concentration
- Reduced stress-whitening on ejection, leading to faster cycle times

Conclusions

Injection molding customers are under increased pressure to lower production cost and improve their environmental footprint. These two aspects can typically be achieved by using additive and/or investing in new equipment. This article summarizes several laboratory investigations and actual case studies on the use of FT molecules as internal processing aides.

Laboratory studies showed that FTPA can reduce the melt viscosity significantly, while (if added at concentrations below 4-5%) it will not significantly reduce the mechanical properties. Some mechanical properties may even show a slight improvement (e.g. stress at yield). The case studies showed that these FTPA can be used in many injection molding applications and result in a significant reduction in cycle time and energy consumed. It can also be a tool to improve the sustainability of the process by lowering the energy requirements and also by reducing the scrap rate and also the wear on the equipment, by reducing the friction and the back pressure in the injection molding equipment.

The addition of FTPA can, therefore, act as a versatile tool in optimizing the injection molding process.

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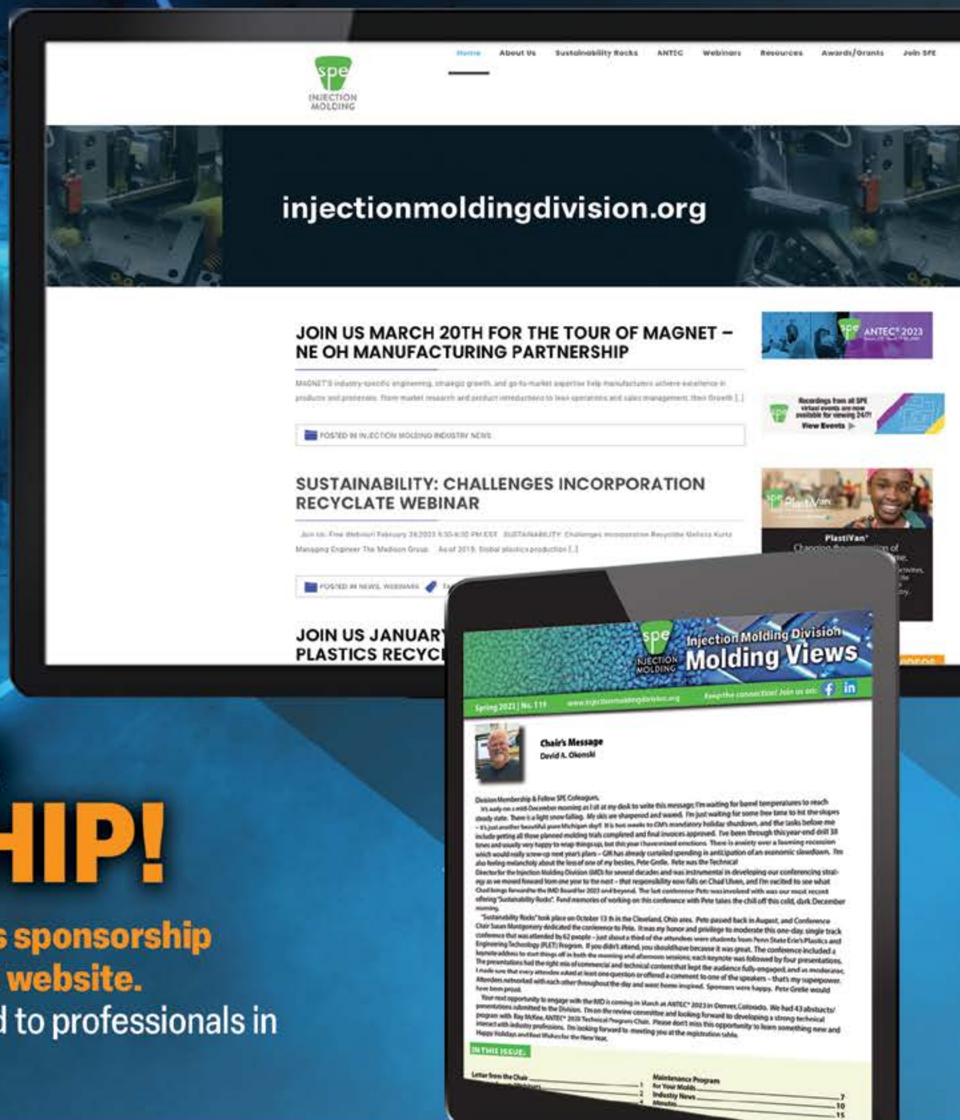

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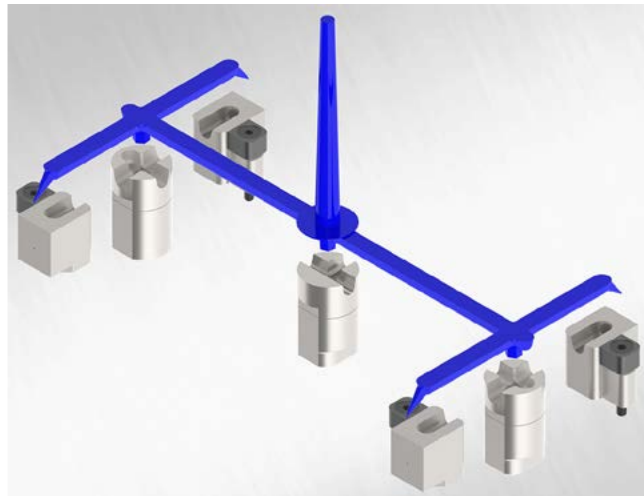
Progressive Introduces Runner Components New Gate Inserts and Runner Turn Offs

PProgressive Components (Wauconda, IL) has added new runner components with the introduction of a Gate Insert and Runner Turn Off as standardized items for controlling a mold's runner system.



Progressive's new Gate Insert offers a compact, off-the-shelf solution to address the issue of abrasive materials opening gates. Gate Inserts are serviceable from the parting line, can be replaced, and provide an option to adjust gate size without re-EDM'ing the gate diameter.

Progressive's Runner Turn Off (RTO) provides a reliable method to block or redirect material flow within the runner, which is especially common with family mold tooling. The RTO offers precise, click-in-place positioning at 45° increments and is conveniently held during the machining of the pre-hardened 420 SS assembly, which is then located into position with a press fit flat. RTOs are available in styles both with and without a center ejector pin.

Gate Inserts and Runner Turn Offs may be used together or independently, as required by the mold's design.

For more information on Gate Inserts, Runner Turn Offs, or Progressive's extensive line of standard and exclusive mold components, visit www.procomps.com, email tech@procomps.com, or call 1-800-269-6653.

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