Thermoforming Quarterly®

A JOURNAL OF THE THERMOFORMING DIVISION OF THE SOCIETY OF PLASTIC ENGINEERS

SECOND QUARTER 2013 ■ VOLUME 32 ■ NUMBER 2

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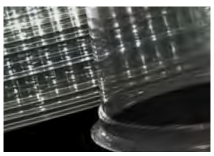









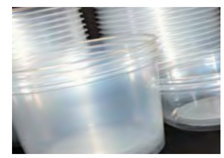

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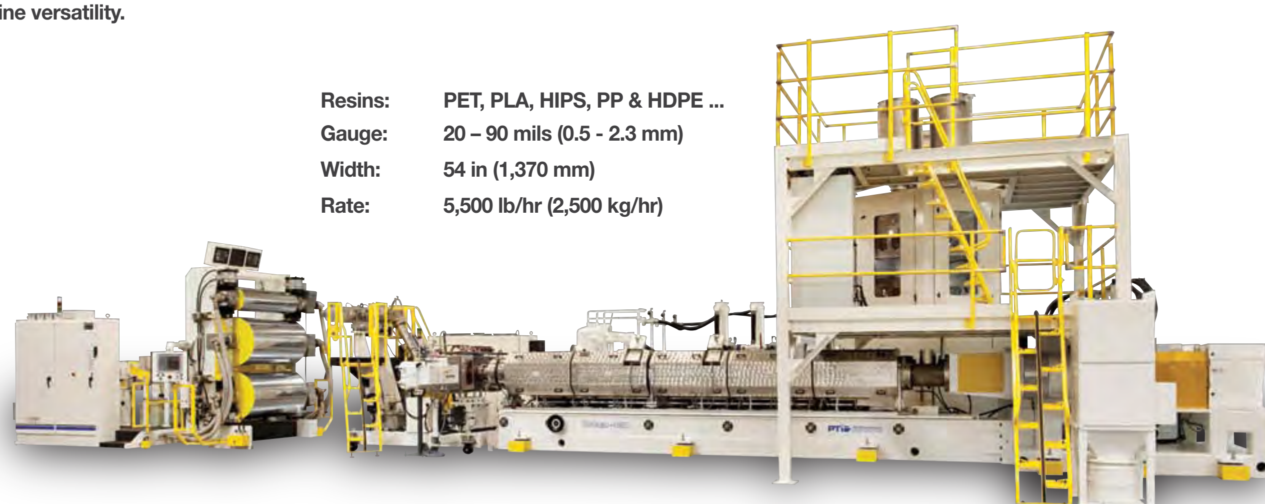

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Features

In This Issue

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Cover Photo: ***Fruit Cup***
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Mark Strachan

Message from New Chairman Mark Strachan

I would first like to thank Phil Barhouse for hs 14 dedicated years of service to the SPE Board and for the honor of serving alongside him as Chair Elect. I have huge shoes to fill, but having the overwhelming support of the Board of Directors makes the acceptance of the gavel and the responsibilities that go with it a whole lot easier. This Board is comprised of volunteers, all of whom are taking valuable time from their respective businesses to help promote the thermoforming industry. In fact, I spent some time with Board Member Emeritus, Art Buckle, at his home in San Diego to get a deeper appreciation for the roots and origins of this board. The efforts of those who began this group and laid the foundations for its success today will be commemorated in a new "History" section of the website. Like many others, I am truly grateful for what these pioneers achieved.

During my tenure as Chair, I will be encouraging closer involvement of the SPE Thermoforming Board Members. If you are reading this letter, then you are one of 1600+ important members of this Division that I hope will take the time to help us to fulfill our mission: the promotion of thermoforming education and development of the thermoforming industry.

Throughout my numerous in-house training sessions both nationally and globally, I get to meet so many brilliant thermoforming product designers, tooling engineers and process specialists (you know who you are!) I am very hopeful that these individuals will step up to the plate and give back to the industry that supports them. We all stand to benefit from this vast pool of experience through the networking opportunities that are created through attendance at the SPE Thermoforming Conference and through our Thermoforming Division LinkedIn site.

Over the next six months, you will have the opportunity to learn more about each Board Director and their respective technical committees – materials, machinery and processing. You will be strongly encouraged to play an integral part in the election of those who best represent your process to the thermoforming community.

We would like to continue to improve the content of our flagship publication, Thermoforming Quarterly, and therefore I strongly encourage you to send us your feedback and constructive criticism. Your contributions in the form of technical articles, whitepapers, letters to the editor and industry best practices are always greatly appreciated.

This year's SPE Thermoforming Conference Show Committee has an exciting agenda planned for us this year in Atlanta. In addition to the thick-gauge / cut sheet and the thin gauge roll-fed workshops offerings, we now have Tim Womer presenting a full day workshop on sheet extrusion. Along with a full house of exhibitors, we have a very exciting line up of whitepapers and innovation briefs that is guaranteed to leave you with a lot of food for thought. Please take the time to enter your best innovative parts into our Parts Competition and take the time to cast your vote during the conference. Please contact Jim Arnet (or download the necessary forms available on the conference website now} to submit your parts.

Our Communications Committee, spearheaded by Clarissa Schroeder of Auriga Polymers, has already changed the face of our website and continues to make it the go-to portal for everything thermoforming. With the development of our LinkedIn site, we plan to take the latest developments in the International world of thermoforming to those who take the time to get involved. Over the next few months you will be hearing more from us. We recognize that your feedback is critical to the vitality of our division. Let us know what you think.

Thank you for your support of the SPE Thermoforming Division and prepare yourselves for exciting times ahead in the wonderful world of thermoforming!

Mark Strachan

Zamec Back as President of Former TriEnda Thermoforming Plant

By Frank Esposito
Senior Staff Reporter, Plastics News

Published: April 25, 2013 3:45 pm ET
Updated: April 25, 2013 4:09 pm ET

PORTAGE, WIS. — Less than a week after being threatened with liquidation, Spara LLC on April 23 regained control of Lexington Logistics, a Wisconsin-based thermoformer that previously operated as TriEnda LLC. Lexington, Ky.-based Spara said longtime TriEnda CEO Curt Zamec has returned to the firm as president. Spara said it "has immediately deployed a management team to assess and stabilize" Lexington Logistics, a 150-employee firm based in Portage, Wis.

Cincinnati-based Fifth Third Bancorp had filed a complaint April 18 in circuit court in Columbia County, Wis., asking that Lexington Logistics be placed in receivership for non-payment of a loan totaling almost $23 million. According to court documents, a court-appointed receiver would have had the authority to liquidate the property in order to pay the debt.

Spara and its parent firm — Revstone Industries LLC of Southfield, Mich. — had filed for bankruptcy in December. But officials with Spara and with Huron Consulting Group — the Chicago-based firm working to restructure Spara and Revstone — said the bankruptcy will not prevent Spara from putting together a new business plan for Lexington Logistics.

"The purpose of the receivership action…was not to liquidate the company," a Spara spokeswoman wrote in an April 24 e-mail. "Rather, it was to facilitate a sale of the company to a new owner and to repay the Fifth Third loan." Spara said it is collaborating with Fifth Third Bancorp." With the corporate governance now settled, Lexington Logistics intends to demonstrate the stability of the company and eliminate the need for Fifth Third to proceed with the receivership," she added.

Fifth Third "pulled back on the [receivership] hearing" in order to give Spara time to put together a new plan, said Jim Lukenda, a deputy chief restructuring officer with Huron.

In November, financial firm Boston Finance Group of Clearwater, Fla., had removed five TriEnda executives and placed Zamec on a leave of absence because of an unpaid loan. Spara had used the loan — which, according to court records, was for $6.7 million — to buy TriEnda in a foreclosure sale in June 2011.

When Boston Finance took over Lexington Logistics in November, five Boston Finance officials were installed as managers. Lukenda said in an April 25 phone interview that Fifth Third's $23 million loan to Lexington Logistics was separate from Boston Finance's loan to Spara.

In an April 24 phone interview, Boston Finance executives John Fernando and Jonathan Golden said they were "shocked" by Fifth Third's receivership filing and suggestion of liquidating the company.

"Our goal was to stabilize and run [Lexington Logistics] and we had worked aggressively to turn the company around in these last four or five months," said Fernando, who had served as the firm's president from November until January, when Mike Ceming was brought in. "We weren't interested in liquidating and eliminating jobs."

"Order flow and revenue were increasing, but [Fifth Third] chose not to work with us, and we don't understand why," he added. Fernando described the Fifth Third filing as "a very extreme measure," adding that once it was made, Boston Finance opted to return voting control to Spara, since it did not own the company in spite of the unpaid loan.

A Fifth Third spokeswoman declined to comment on Lexington Logistics or on the bank's court filing. Boston Finance "was very pleased with the customer base, the employee base and the vendor base" at Lexington Logistics, Fernando said, and officials believed that the firm "was headed in the right direction."

Golden added that Boston Finance had invested $750,000 of its own funds into Lexington Logistics since November to help the firm meet payroll and make vendor payments. He added that his firm was not confident it would ever get that money back, or be repaid on the initial $6.7 million loan it made to Spara.

Back in November, Jonathan Golden told Plastics News that Spara had not paid on the loan and that his firm elected to exercise its lender remedies by exercising its voting rights that were spelled out in the loan agreement. A Spara spokeswoman confirmed on April 24 that Spara had not repaid the loan from Boston Finance. Lexington Logistics ranked as North America's 29th largest thermoformer in a recent Plastics News ranking. The firm's annual sales were estimated at $55 million.

Lexington Logistics occupies a 273,000-square-foot plant in Portage and specializes in the design and manufacture of heavy-gauge, single-sheet and twin-sheet plastic thermoformed products. Zamec was 2007 Thermoformer of the Year, an honor bestowed annually by the Society of Plastics Engineers' Thermoforming Division. |

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Correction to recent article in Thermoforming Quarterly

In the previous issue of ***Thermoforming Quarterly*** (vol. 32, no. 1), one of the graphs in Douglas Hicks' article, "The Dangers of Direct Labor-Based Costing in Manufacting," was printed without complete information. The correct graph appears below. We apologize for any inconvenience.

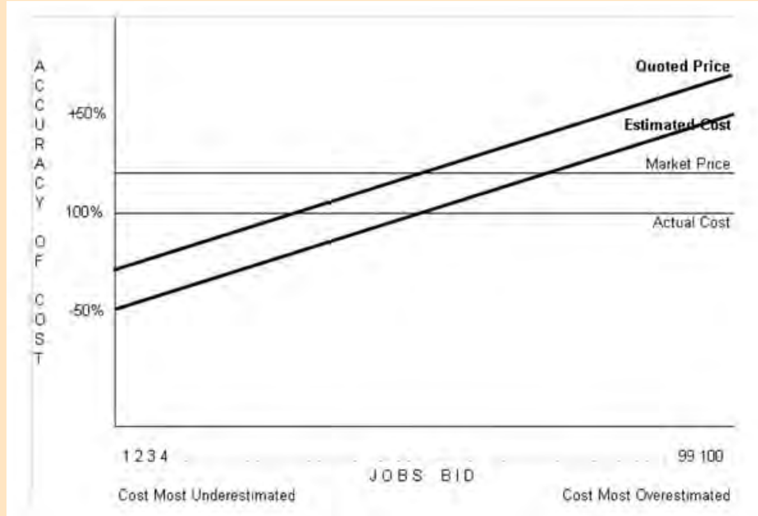


Figure 2 – Pricing Based on Over-Generalized Costs.

Enhanced Gas Barriers in Thermoformed Trays

By Mark Roodvoets, Auriga Polymers
Spartanburg, SC

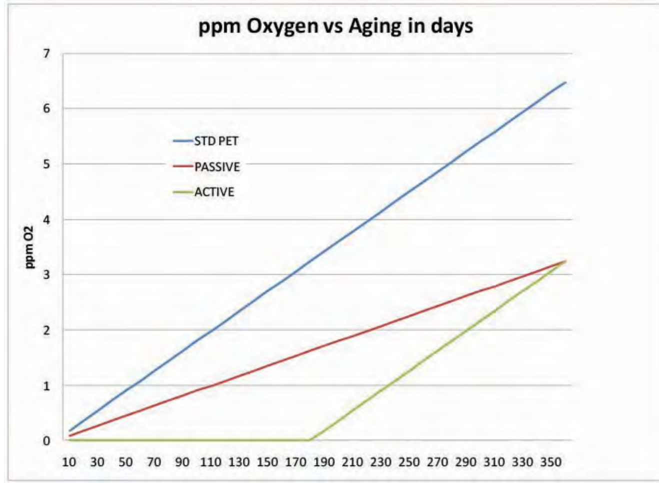
Barrier Background

There are many barriers required in thermoformed tray packaging of foods. These can include barriers to tampering, barriers to either visible light for milk or UV light for nutrients, flavors, and colors, or barriers to various gases. Gas barriers are the topic of this paper.

There are three main gases that can cause problems for foods: oxygen, carbon dioxide, and water vapor. Water vapor barrier is measured as WVTR or water vapor transmission rate and is very low for polyolefins. PP has 5x the water vapor barrier of PET. Dry foods often require a moisture barrier. CO_2 barrier is generally required for carbonated beverages and has the added complexity of creep[1]. This is generally restricted to bottles not trays due to the internal pressure. CO_2 barrier can be measured as volumes of CO2.

Oxygen Barrier

Oxygen can spoil many liquid and solid foods such as cheese, meat, beer, wine, tea, ready to eat meals, and any foods containing certain vitamins and nutrients. Some plastics are inherently better for protecting contents against oxygen permeation. Polyolefins like polyethylene and polypropylene are very porous to oxygen and provide little protection. PEN (polyethylenenaphthenate), polycarbonate, EVOH (ethylene vinylalcohol), and nylon have good natural barrier to oxygen. Polyethyleneteraphthalate (PET) is in between. Oxygen barrier is measured as BIF (barrier improvement factor) for passive barrier and OTR (oxygen transmission rate) for active barriers. A passive barrier is one that just slows down the permeation of gas while active barriers absorb or react with the gas. The following chart shows the difference.



Using PET as a control with the blue line, the transmitted oxygen continues to increase the same amount each day. A passive barrier is depicted by the red line which shows a BIF of 2:1, twice the barrier or one half the permeation of the control. Oxygen content still climbs at a constant rate. The green line shows an active barrier with a shelf life of one half year. After six months, the rate becomes close to that of the control. In this case, if the barrier requirement is a total of 2 ppm oxygen, then the following shelf lives would be observed:

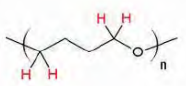
PET: 110 days (this is where the blue line crosses the 2 ppm O2 line.)
Passive: 220 days (this is where the red line crosses the 2 ppm O2 line.)
Active: 290 days (this is where the green line crosses the 2 ppm O2 line.)

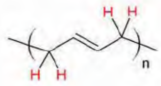
Examples of passive barrier include multilayer structures where an inner layer of nylon or EVOH provides better barrier. Additives such as mica, nano clay, and nylon can also be used. These provide a tortuous path for oxygen. Shelf life is controlled by the thickness of the barrier layer or by the amount of barrier additive added to a mono-layer film. Examples of active barrier are OxyClear®, Amosorb®, MXD6®, and Diamond Clear®. These are all scavenger additives and are used typically between 1% and 5% let down ratio (LDR)[3]. Shelf life is controlled by the amount of scavenger additive that is added. Some foods are very sensitive to oxygen. Beer can only take about 1 ppm O2, while juices and meats are fine with 5-10 ppm. These scavengers usually require a transition metal catalyst such as cobalt stearate. The chemical structures all contain active hydrogens that can react with oxygen in a free radical chain reaction forming hydroperoxides. These are the generic structures of some oxygen scavengers.

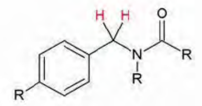
In theory, the scavenging stops when all labile hydrogens are

1 Creep is the tendency of a plastic to stretch under load for an extended period. In the case of a beer bottle, the volume increases, which reduces the carbonation pressure.
2 Tortuous path is the term referring to path a gas molecule must follow to get from the outside of a package through the package material to the inside of the package. When materials with very low permeation rates like inert fillers are incorporated into the resin, then the gas molecule must go around the inert filler and the tortuous path is longer and the barrier is enhanced.
3 Let down ratio is the percentage of additive. Typically 1% to 5%.

OxyClear® Amosorb® MXD6®







turned into hydroperoxides. In practice, they are only 50-75% efficient.

Measuring Oxygen Barrier

Measuring barrier can be done in several ways including filled tray testing, empty tray testing, head-space testing, and accelerated testing.

Filled tray testing is accomplished by placing an oxygen sensitive "dot" in the head space inside of the tray where it can be scanned by a light sensor measuring fluorescence. These machines are portable and cost $10-15k. Their advantage is their true life situation with actual product. The disadvantage is that a leak in another part of the tray might go undetected and there is generally no way to accelerate the aging. Another method takes one package per test and measures the oxygen in the headspace directly. This has the same advantages and disadvantages.

Empty tray testing is done by mounting a tray on a fixture and hooking it up to an oxygen sensor such as is made by MOCON or Illinois Instruments. These machines can handle multiple specimens per machine and have the advantage of being able to be removed and put back on the machines at regular intervals to measure the OTR vs. time. They can also be aged faster as discussed later.

A third mode of testing is called head space testing, where packages are cut up or ground and put in a glass jar with a know concentration of oxygen. The oxygen is then measured versus time. This method does not take into account the tray configuration and could lead to a false positive result. It can however be accelerated. This leads to a measure of oxygen capacity per gram of scavenger. An efficiency factor must be applied.

Shelf life testing can be accelerated in empty package testing or head space testing. Either method can be accelerated by a factor of 2 for each 10°C increase in temperature. Empty tray testing can also be accelerated by a factor a five by using 100% oxygen instead of the normal atmospheric level of 20%. False positives are an issue here if a scavenger works at the higher temperature but is not active at lower temperature. Some active barriers are also active at RT but not at refrigerated temperatures.

Application Considerations

There are many considerations to keep in mind when using a barrier in thermoformed trays. Here is a list of some of them:

1. **Thickness** – The barrier is generally proportional to the barrier layer thickness. There may also be a minimum thickness required that is dependent upon the level of barrier additive. Below this level, oxygen may permeate freely without having enough contact with the scavenging additive. The thinnest part of the tray usually determines the shelf life, so uniform thickness is more efficient.

2. **Head space oxygen** – Some scavengers are strong enough to scavenge the oxygen out of the headspace. Starting nitrogen and oxygen partial pressures must be considered.

3. **Modeling** – Trial and error might be required for final fine tuning, but there are models such as the Mark Rule Model[4] that can be used to predict the required barrier and thickness levels to obtain the desired shelf life. Suppliers and third party agents can run these model simulations or access to the models can be purchased.

4. **Shelf life** – As stated before, the shelf life is generally proportional to the thickness of the thinnest region and the concentration of the scavenger or proportion of the scavenger layer. Rolls of barrier film tend to have very long shelf life because only the outer layer of the roll is exposed to the atmosphere. Removing a layer or two before thermoforming assures fresh scavenger. Shelf life usually starts when the tray is thermoformed.

5. **FDA** – There are many different types of foods that are processed in different ways. They are classified by Group and Conditions of use. The Group depends upon the food makeup, such as fatty foods. Conditions of use could be "retort" or "hot-fill". For instance, an additive may be cleared for juice applications but not for fatty foods or may be cleared for hot fill but not for retort. The migration testing is different for these various requirements. The proper clearance must be obtained. There are also different rules for different countries. A system that is approved in the US may not be approved in Canada or elsewhere. China, the EU, and Mercosur countries all have their own requirements, for example. Some countries also employ an approved materials list that may need to have the material added. DFC or direct food contact has more stringent rules than an interior layer additive. Is may be possible to use a higher level of barrier in an interior layer than a contact layer. It is the responsibility of the end user to identify the food class and conditions of use desired for a package. It is the additive producer's role to have extraction tests run and obtain the proper approvals and let the converter know the barrier additive or system use limitations. Keep in mind that the additive and the base resin system it is used in must be considered together. One company's scavenger may not be approved with another company's catalyst masterbatch, for example.

6. **Patents** – It is also the barrier supplier's responsibility to know the IP (intellectual property) situation and provide assurances to the converters and end users that they will not face litigation.

7. **Regrind** – With the high level of trim from edges and web scrap in thermoforming, it is important to know where and whether the barrier layer may be reground and added back into the barrier application or another application. It is often possible to at least regrind the edge scrap and re-use it directly. It is also common to limit the use of barrier regrind in the barrier application and instead, use it in another higher volume application at a lower level. Many barrier systems cause yellowing at some level from thermo-oxidative degradation. Since they are designed to oxidize at room temperature, it is easy to see how

4 M-Rule Model® available from Container Science

they would oxidize must faster at dryer or extruder temperatures. Because of this, you cannot include the barrier in the regrind as available for scavenging.

8. **Recycle** – Most barrier products will not pass the APR Critical Guidance protocol where 25% and 50% recycled product are incorporated back into virgin PET and put through additional heat cycles. Yellow oxidation byproducts are the reason that many barrier resins do not pass APR critical guidance. There are newer recycle protocols like EPBP[5] that treat barrier additives as low volume specialty resins and test them at lower levels such as 5-10%, where some of them may pass. There is also an ongoing debate whether to put a "1" on the bottom of the package or not. Some consider this code as an identification code, while others refer to it as a recycle code.

Conclusions

This is just a sampling of the issues involved in providing a thermoformed package with an enhanced barrier. The brand owner, convertor, and barrier supplier need to work together for the best solution and test final product to assure a success. Planned properly, thermoformed packages can have extended shelf lives by providing various barriers through material selection and use of additives.

About the Author

Mark Roodvoets has a BSChem from University of Michigan, an MS in Polymer science from Akron University, and an MBA from Kent State. He has worked at Firestone Tire and Rubber Central Research as a Sr. Research Scientist, Romeo RIM as the VP of Production, Spartanburg Steel Products as VP of Aseptics Division, and currently is R&D Manager of Barrier Platform and Pilot Facilities for Auriga Polymers, division of Indorama Ventures.

5 European PET Bottle Protocol

Relating Polymer Viscoelastic Properties to Thermoforming Process – A Short Review –

By Rabeh H. Elleithy, Printpack Inc., Williamsburg, VA

Abstract

This paper reviews the relation between polymer viscoelastic properties and the plug-assist thermoforming process. One of the important attributes of polymers is their macromolecular interaction. Molecular interaction provides enhanced networks of molecules that contribute to minimizing polymer deformation at high temperatures. As a result, sheet sagging will be reduced during thermoforming. Additionally, molecular interaction could enhance the melt strength of the polymer by reducing its molecular mobility.

Introduction

The steps of the plug-assist thermoforming process are schematically depicted in Figure 1.

Figure 1: Schematic presentation of the plug-assist thermoforming process.

The first step is sheet extrusion, followed by feeding and heating the sheet. Then, forming the product and cooling them to their final shape. To successfully apply these steps, we need to understand the resin rheology, thermo-mechanical behavior, and thermal & viscoelastic properties. For example, polymer rheology is very important in determining the optimum conditions of sheet extrusion. Equally important are the viscoelastic properties because they determine the processing window for thermoforming process. The thermal properties are used to estimate the heat required to soften the extruded sheet enough to enable the forming of the products. Evidently, these polymer properties influence the behavior of the extruded sheet, which affect the properties of the thermoforming process. Hence, having insight about some viscoelastic properties of polymers will help us better understand the parameters affecting the thermoforming process.

Review

Sheet Sagging

Rheological properties of polymers play a major role during most of the polymer conversion processes, e.g. thermoforming. Figure 2 shows the rheological behavior of two grades of high impact polystyrene, *HIPS*, at 170°C [1].

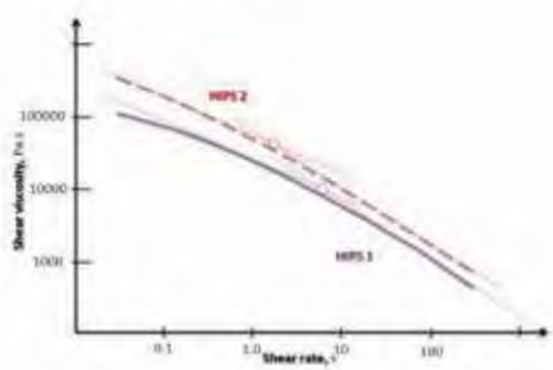


Figure 2: Representation of the viscosity vs. Shear rate of two grades of HIPS at 170°C [1].

At the same shear rate HIPS 2 has a higher viscosity than HIPS 1. In other words, HIPS 2 would need to be processed at a higher temperature or at a higher shear rate to flow similarly as HIPS 1 flows. Moreover, the transition point (indicated by a circle in Figure 2) of HIPS 2 occurred at a lower shear rate than that of HIPS 1. These two characteristics of HIPS 2 (higher viscosity and earlier transition point) would suggest that the molecules of HIPS 2 have more cooperative interactions than those of HIPS 1. This cooperative interaction of molecules is an indication that HIPS 2 has more close-knit molecular network. This molecular network plays an important role in thermoforming process. As indicated by Woelfe et. al., HIPS 2 has less sag than HIPS 1, and this is shown by values of 86 mm and 144 mm, respectively [1]. The high sag resistance of HIPS 2 allows it to be formed at higher temperatures than HIPS 1 which could be beneficial in reducing the residual stresses in the final product.

The loss factor, *tan δ*, is the ratio of the loss modulus to the storage modulus. The loss factor can be regarded as a measure of dissipated, or loss, energy. The relation of tan δ to the frequency, or shear rate, of two different grades of polypropylene, *PP*, at 190°C is shown in Figure 3 [2].

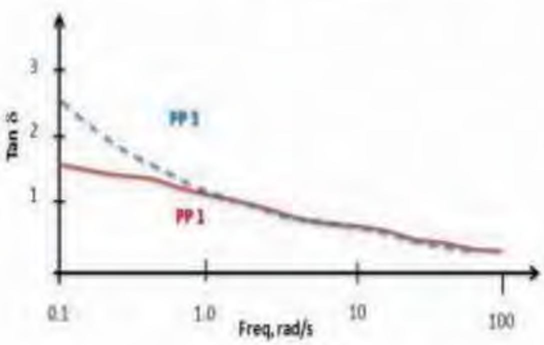


Figure 3: Loss factor (tan δ) as a function of frequency for two grades of PP at 190°C [2].

PP 3 has a higher tan δ than that of PP 1 up to a shear rate of about 1 s^{-1}. After that shear rate both PPs have the same tan δ. Thermoforming occurs at low shear rates where PP 3 has higher tan δ than PP 1. This indicates that more molecules will move and dissipate energy for PP 3 than for PP 1. Hence, PP 3 would have less molecular resistance to deformation than PP 1. This means that PP 3 will have more sagging than PP 1 as seen in Figure 4 [2].

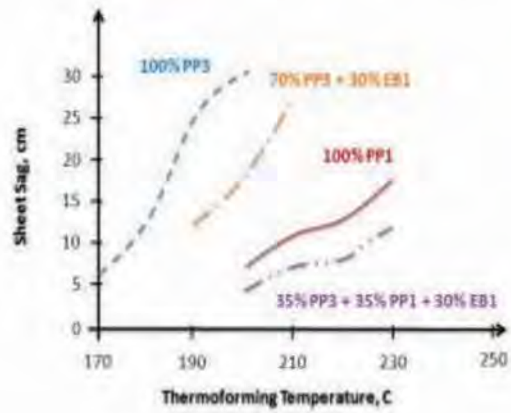


Figure 4: Relationship of thermoforming temperature to shear-sag for PPs and their blends [2].

At the same temperature, about 200°C, PP 3 has about 5 times the sag as PP 1. The sagging of the sheet can be improved by appropriate blending. For example blending PP 3 with elastomer EB 1, at a ratio of 70/30 respectively, reduced the sagging by 50% [2]. Even more improvement of sagging resistance is achieved by using the correct blend of PP 3 + PP 1 + EB 1. Figure 4 shows that this blend has the best sagging resistance among the tested blends [2].

Melt Strength

Lau et. al. showed that the melt strength of PP decreased as the temperature increased due to the ease of molecular mobility at higher temperatures, as depicted in Figure 5 [3]. In their work two types of PP were used: PP ① and PP ⑤. PP ① was a homopolymer with MFI = 2; whereas, PP ⑤ was a high melt strength grade. PP ⑤ has MFI = 2.5 and is thought to contain long chain branching, LCB, [3].

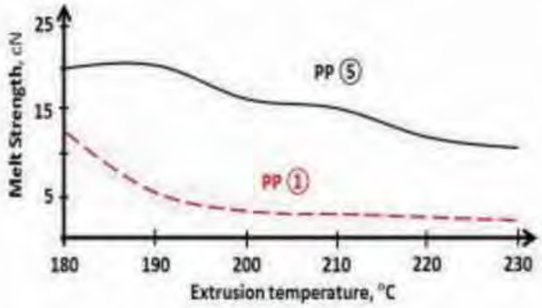


Figure 5: Plot of melt strength as a function of temperature for two grades of PP [3].

At lower temperatures the difference in melt strength between the two grades of PP was not as significant as at high temperatures. The rate of melt strength reduction for PP ⑤ is slower than that of PP ① because the former resin has LCB that restricts the molecular mobility. Restricted molecular mobility increases the resistance to deformation which increases the melt strength especially at higher temperatures. Higher melt strength is very beneficial during the thermoforming process, e.g. it minimizes the chance of tearing during forming thin-wall products.

Melt Elasticity

Figure 6 shows the variation of the loss modulus (G'') as the storage modulus (G') changes for two types of Acrylonitrile Butadiene Styrene, ABS [4]. For homogeneous polymers, the slope equals 2. ABS, as an *"inhomogeneous"* polymer, performs differently than a homogeneous polymer The slope for ABS depends on the level and properties of the rubber particles blended in the ABS [4]. For example, ABS 24 has a higher level of elastic rubber than that of ABS 12. As the stress applied to the polymer increases, G' value for ABS 24 increases more than that of ABS 12 for the same G'' due to the increased elasticity of ABS 24, as shown in Figure 6. This will increase the melt elasticity of ABS-24 as compared to that of ABS-12 [4]. It is known that the level of melt elasticity affects the way polymers retain their shape inside the mold.

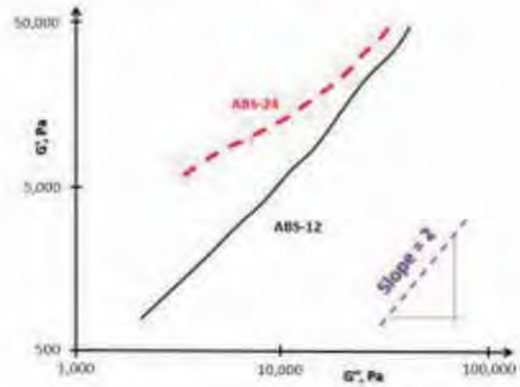


Figure 6: Loss modulus (G'') vs. Storage modulus (G') plot for two types of ABS [4].

Concluding Remark

Various authors, e.g. J. L. Throne [5], discussed polymers' properties in relation to thermoforming. However, this short review is an attempt to summarize, in an easy-to-read format, some of the important viscoelastic aspects of polymers and to relate these aspects to basic attributes of thermoforming.

Acknowledgement

I would like to thank Printpack Inc for giving me the chance to present this review paper at ANTEC 2013.

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Keywords: Polymers, viscoelastic, properties, and thermoforming.

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The Wonders of Plastics

— An Essay —

by Abraham Gutierrez

Editor's Note: Abraham Gutierrez is a senior at Ontario High School in Ontario, CA who enjoys math and science, specifically calculus, environmental science, and physics. He has received letters of acceptance from many of the top universities in California as well as the prestigious Worcester Polytechnic Institute in Massachusetts. Abraham's intended major is Environmental Engineering.

This essay about the Wonders of Plastics is the result of an assignment from his AP Environmental Science (APES) teacher, Mrs. Rowley, who encouraged her students to take part in an opportunity to write about the benefits of plastics. The essay appears as it was submitted to TQ.

Whether we are aware of it or not, plastic is all around us and plays a crucial role in our daily lives. Ranging from children's toys to massive transportation units and from soft drink bottles to school supplies, it has become one of the most prevalent materials in the world. Likewise, this synthetic solid is a prominent resource for humans in terms of production and consumption. Despite its flaws and much opposition, plastic has become a great success due to its product versatility and its energy-saving efficiency.

America has a population that must be satisfied by giving its people what they need and want. Simply, plastic is the perfect material for the satisfaction of every individual's needs and wants due to its high versatility. Interestingly, it has the right properties to be manufactured in ways that serve specific purposes and functional needs for consumers. Historically, preventing the spoiling of stored food was always a challenging task; however, with the introduction of plastic wraps and re-sealable containers, protecting food from contamination has become much easier. On the same note, food companies always had difficulties of how long their products are able to be on their shelves before they become expired. Luckily, modern packaging helps keep food fresh for a longer period of time, even with food that expires relatively quickly such as beef and chicken.

Aside from its wide use in food packaging, plastic also plays a pivotal role in terms of our modern daily household appliances. Due to its extremely high durability, plastic is used in nearly all items found in today's conventional home. For instance, these synthetic solids are used in portable phones and laptops not only because they help reduce any possibilities of shattering, but also because they are fairly light, making portable items truly portable. In addition to phones and laptops, plastic is utilized in major appliances, such as dishwashers and refrigerators to help resist corrosion, last longer, and operate much more efficiently. In the end, the benefits of using plastic will only grow and grow as more of its uses become a part of contemporary life.

Finding a better energy-saving material has always been a goal for American businesses. Plastic has been found to be very inexpensive and effective in saving energy through its production and consumption, especially when compared to other widely used materials like paper. In fact, during its production, one plastic bag requires only two-thirds of the energy needed to produce one paper bag. By using plastics rather than alternative materials, manufacturers save large amounts of energy. Without this reliable material, the energy needed to produce just packaging materials would nearly double. Also, due to their light weight, plastics have been effective in reducing the weight of delivery trucks, allowing them to carry more units. The fact that more units are able to be carried allows the need for many trucks to decrease, saving large quantities of energy. This shows the significance of using plastic rather than using other expensive, energy-consuming materials.

All in all, plastic has always been around us for as long as we can remember. Its many uses only allowed it to emerge as the prime material in many household items and utilities. Outside the home, it has also gained popularity in local markets and warehouses because of its packaging qualities. Most importantly, plastic saves energy. Many times, people are asked the question, "Paper or plastic?" It turns out that creating plastic materials requires only a fraction of the energy needed to create other materials. In the end, the pros gained from using plastic are far more beneficial than those gained from alternative sources; as a result, it has become one of the most indispensable substances in the world.

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"PPT270: Thermoforming" at Pennsylvania College of Technology

by Kirk Cantor and Chris Gagliano

When operating at their best, industry and academia share a synergistic relationship with each party benefiting substantially from the contributions of the other. Industry can provide educational institutions with modern resources such as equipment, technology and funding which ensure that schools remain current and able to provide innovative concepts and workers with relevant skills. Academia can provide companies with ideas to improve products and processes that save time and money and, perhaps most importantly, personnel who ready to make significant contributions on their first day of work.

As the Spring 2013 college semester draws to a close, we reflect on the first installment of a superb example of this industry/academia synergy. At the Pennsylvania College of Technology in Williamsport, PA, PPT270: Thermoforming was conducted with 17 sophomores in the Plastics and Polymer Engineering Technology bachelor degree program. The Penn College plastics program is one of only five in the country accredited by ABET and the first ABET-accredited program nationally to offer a thermoforming course for academic credit.

This course is one of the more successful results of the thermoforming industry collaborating with an academic program. It is co-taught by an industry practitioner with over 25 years of thermoforming experience in design, mold building, set-up, operation, job quoting, and management and a professor with over 25 years of teaching and research in plastics and polymer engineering. Together, they have been able to deliver a large amount of both hands-on and theoretical content to the students during this first offering. The course includes 2 hours of lecture and 3 hours of laboratory each week.

The centerpiece of the hands-on laboratory sessions is a MAAC 3' x 4' single-station shuttle thermoforming machine. This is a perfect example of industry and academia working hand-in-hand for mutual benefit. This custom-designed machine came to the college through the Thermoforming Center of Excellence (TCE), an industry-focused R&D facility under the direction of the Plastics Innovation and Resource Center (PIRC) at Penn College. The PIRC is an academia/industry/government collaboration that serves the plastics industry by acquiring funding and leveraging production-sized equipment, faculty expertise, and student labor to meet the research, development, and training needs of the plastics industry. Along with the machine manufacturer, approximately 20 other equipment and material suppliers, engineering and professional organizations, and thermoforming processors are major sponsors and/or charter members of the TCE.

Students in PPT270 have become very valuable potential employees of the thermoforming industry because they have gained a substantial amount of experience working with thermoforming machinery and ancillary equipment. Over the course of the semester, students have developed the following skills on industrial-sized machines: safe operation and mechanical aspects of the machinery; set-up of hardware for a production run (clamp frame sizing, oven settings, vacuum and pressure levels, platen positions, etc.); installation of molds, plug assists and pressure boxes; program control software; construction of vacuum boxes; actual forming of parts with vacuum only and parts with vacuum and pressure; investigation of forming various materials; part quality evaluation and many supporting tasks. Many of the lab sessions have involved industry-related projects so there is always an emphasis on translating the knowledge to a production environment leading to customer applications.

In addition to the lab sessions, students learn thermoforming theory in the classroom. Presentations and discussions are organized around the primary subjects facing all thermoforming companies: hardware systems, material types, part design, mold design, heating the sheet, part forming, cooling the sheet, and trimming. Issues specifically related to roll-fed and thin-gauge forming are addressed separately from those related specifically to cut-sheet and heavy-gauge forming. Several text books and technical articles along with hands-on experience contribute to the theoretical content covered in class.

Since this is the first offering of the course, many ideas for future improvements have been generated. New equipment, both primary and secondary, will allow for opportunities to incorporate further technologies. Additional industry-based projects are planned in order to expand the number of techniques (e.g., forming and trimming methods, quality measurements, etc.) to which students are exposed.

Nevertheless, even for an initial effort, the reviews and feedback have already been very encouraging. The expectation is that even this first cohort of students in the class will be of great interest to the thermoforming industry and that major decision-makers throughout the field will be keeping track of the progress of both this course and the students who take it.

Anticipating completion of the first production part

Ready to send the sheet into the oven

A successful part: lamppost-mounted based liner for a local municipality

Learning to accurately trim the part

The Sustainability of Sustainability: Getting to ROI

This article is adapted from "Dordan's Sustainability Efforts Drive Innovation, Raise Questions" by James J. Callari, Editorial Director, Plastics Engineering (March 2013). The article highlighted the sustainability efforts at Dordan Manufacturing. This updated piece was written in conjunction with Chandler Slavin, Sustainability Coordinator at Dordan, to further examine an important question raised in the original: is the push for sustainability truly sustainable at small and medium-sized businesses?

For many thermoformers, sustainability is a serious, complex and evolving issue with elements that touch virtually every aspect of their business. From materials to power to scrap to final product to shipping to end-of-life choices, the full cycle of making a thermoformed part is being analyzed in tremendous detail.

Sustainability is a matter around which many thermoformers, especially those who design and produce packaging, are still trying to wrap their arms because there are so many means to that particular end. You'd be hard-pressed to find a website in the plastics industry without a sustainability link on it. With major brands examining their supply chain in an effort to track, report and reduce carbon emissions, many processors have been forced to adapt to changing customer requirements. In response, more than a handful of companies have hired people to lead their sustainability efforts. As an emerging thought leader in this space, Dordan Manufacturing sees positive results in the form of satisfied customers. In pushing further, however, the company is posing a tough question: is sustainability truly *sustainable* as a business model for small- and medium-sized thermoformers?

ALL IN ON SUSTAINABILITY

It would be hard to find anyone who has been more energetic and visible in making sustainability part of her company's culture than Ms. Slavin. She came to the company with a bit of hands-on thermoforming experience gained from working summers and after school at the family business over the years. Ms. Slavin didn't just dip her toe into the sustainability pool; she dove in head-first.

Following her recommendation, Dordan joined the Sustainable Packaging Coalition, an industry group of packaging suppliers, food companies, OEMs, materials suppliers and industry consultants. There, she found-out that thermoformed packaging was not recycled in most communities, and visited various waste-management facilities to find out why. Harnessing the power of social media, Ms. Slavin's next move was to launch a blog to raise awareness about end-of-life options for thermoformed packaging. People noticed, notably the sustainable packaging coordinator at Walmart Canada, who asked Ms. Slavin to serve as the co-lead the PET Subcommittee of the Material Optimization Committee. This working group was dedicated to increasing PET recycling in Canada, including PET thermoforms. Six months later, she wrote a white paper titled, *Recycling Report: the Truth about Clamshell/Blister Recycling with Suggestions for the Industry*©, which outlined the main obstacles keeping thermoforms from being recycled in the United States and contained options to overcome identified obstacles. While it managed to ruffle a few feathers in the world of PET recycling, Ms. Slavin nevertheless presented her findings at numerous conferences. The most recent *Report on Postconsumer PET Container Recycling Activity* from National Association for PET Container Resources (NAPCOR) and the Association of Postconsumer Plastic Recyclers (APR) included PET thermoforms for the first time, reporting than 45 million lb of them were recycled in 2011 (*see TQ vol. 31, no. 1 for information on the NAPCOR efforts*).

"During this time Dordan developed sustainability tools and services that have helped us work with clients to design more sustainable packaging systems," states Ms. Slavin. "One of these is called COMPASS (for Comparative Packaging Assessment) which is an online program for packaging designers and engineers to assess the human and environmental impacts of their packaging designs."

"We subscribed to the Walmart Scorecard Modeling 3.0 software, where we learned how to design packaging that would achieve better Scores. We created a 4-Step Design for Sustainability

(DFS) Process, where customers were provided with an easy approach to facilitate quantifiable environmental savings. And we developed what we call the 'Bio Resin Show-N-Tell', which now contains nine alternative resins like PLAs, PHAs, Bio-PETs and includes associated specs and a cost analysis."

Most of these efforts have borne fruit. For example, the program put the elements of the DFS process (lower product-to-package ratio, materials selection, materials reduction, and sustainability documentation) to use in a package redesign project. To reduce the product-to-package ratio, the process changed the clamshell from convex to flat, thereby eliminating the snap-on lid. It reduced the gauge of the clamshell from 0.030 in. to 0.025 in. and the inner tray from 0.045 in. to 0.035 in.

Using the Walmart software, a tool that allows companies to find potential sustainability improvements in their product packaging, Dordan demonstrated that the redesign resulted in a 29% cost savings compared to previous package. For the same amount of product sold, the total packaging weight was reduced by 25% and $C0_2$ emissions were reduced by 25%. The slimmer design further allowed for more products per pallet and an increased number of units per foot of retail space. The numbers speak for themselves. The customer is clearly the beneficiary of these results, measured both in costs and environmental benefits. But how much does this cost Dordan?

WHAT NOW?

It has been said that those leading the charge into battle are most likely to experience the brunt of the enemy's defense. In the case of sustainability, though, there is no enemy. Big-box retailers are pushing OEMs to comply, OEMs in turn are demanding sustainable solutions from their packaging suppliers. All of this costs money. Who is going to pay?

Says Ms. Slavin, "Internally, we began to discuss the repercussions of our efforts on Dordan's bottom line. While it has earned us publicity and enhanced our brand identity as thought leaders, it is difficult to quantify the ROI. Often I hear from our sales team that the people they are selling to are not really interested in sustainability, just cost. While our corporate blog had gotten a ton of traffic, it wasn't the 'right' type of traffic insofar as generating qualified leads is concerned," she concedes. "While we had hundreds of people download our white papers on sustainability, they were usually competitors, suppliers, or consultants. We were at a crossroads, where the initial idealism of 'sustainability' began to give way to the reality of business. How much of our recent success is the result of our sustainability efforts, and how much the result of 50 years' experience in the business?"

Ms. Slavin offers: "If sustainability for our customers is not a purchasing priority, if consumers won't pay more for sustainable products and packaging, and if we are but a fraction of the contribution to the carbon footprint associated with the products we package, why do we continue to invest so heavily in it?" Dordan's investment includes salaries, industry association memberships, travel, LCA licenses and time.

It might be a while before the answers to the question Ms. Slavin poses are answered. The market for sustainable packaging—despite the forces presumed to be behind it—is embryonic. Factors including over-capacity, international competition and weak domestic collection efforts are just some of the obstacles facing this new market. Perhaps some encouraging news can be found in November 2012's Regeneration Consumer Study, an online study that concluded that two thirds of consumers in six countries recognize the need to consume less and purchase products that are good for the environment and society. The survey was conducted by the Regeneration Roadmap, a joint project of Global Scan (globalscan.com), a research firm headquartered in Toronto and Sustainability (sustainability.com), a think-tank and strategic advisory firm headquartered in London. The results were compiled from 6,224 consumers across Brazil, China, India, Germany, the U.K. and the U.S.

Still another study, this one done by MIT Sloan Management Review and the Boston Consulting Group, showed that North American companies are lagging behind firms from other countries where it concerns integrating sustainability models in their business. Compared to companies in other countries, North American firms have the lowest rate of sustainability-focused business model innovation and the fewest business model innovators who said that "sustainability activities added to their profit," according to the study.

The fourth annual study, called The Innovation Bottom Line, was based on a survey of 2,600 executives and managers from companies around the world. Overall, it found nearly half of the companies have changed their business models as a result of sustainability opportunities, a 20% jump over 2011.

COUNCIL SUMMARY

Roger Kipp
Councilor

I am pleased to provide a summary of SPE governance activities and updates on the state of our society. The spring council meeting was held prior to ANTEC in Cincinnati from April 12-14. It would be safe to say that the clear message from our CEO, Wim DeVos is that as a society, SPE is in a "Race for Relevance**.**" Wim's comments at the Council meetings were related to the book, *Race for Relevance: 5 Radical Changes for Associations* by Harrison Coerver and Mary Byers**.** Many of the concepts communicated in this book are in parallel with the direction Wim has initiated during his first year as CEO.

We must look at the realities of today's market place and determine what it will take for trade organizations and professional societies to prosper and stay relevant. There is a need for radical change, not incremental change, because the environment surrounding business and our society has changed considerably. There are six market place realities that are identified in the "Race for Relevance" that did not exist 25 years ago. These new realities have significantly changed the playing field for membership type organizations:

- **Time** – Americans are busier today than ever before working an average of 568 additional hours in 2006 as compared to 1979.
- **Value Expectations** – For professionals being part of their professional society was part of being a professional. This is no longer true.
Market Structure – Services and the functions of the organization must be altered to meet the market place changes.
Generational Differences- Member diversity falls along generational lines because for the first time in history there are 4 generations working together in the workplace. Each generation has its own values when it comes to volunteer service, value expectation, how they prefer to learn, and where their affiliations should be.
- **Competition** – An increase in trade organizations many focused on specialty services.
- **Technology** – Introduction of online information networks where professionals can compare products and services, research data and even network from their desk.

Professional business organizations, like all organizations, need to embrace change in order to off-set the reality of market place variances and overcome the challenge to continuing success.

The path forward suggested in the book recommends five radical changes in order for the organization to thrive, not just survive:

- Overhaul the governance model and committee operations
- Empower the CEO and enhance staff expertise
- Rigorously define the member market
- Rationalize programs and services
- Build a robust technology framework

I am pleased to say that a great deal of work has been done by the Executive Committee and Council during the last year that is in tune with these recommendations. However there is a lot of work that still remains.

The results are evident in many areas though there is also a noted lack of progress in others. The challenge for our organization is to become more agile and to implement continuous improvement of operations. As I noted in my last report, Wim has pointed out to council that we need to increase the speed of change, reduce the number of committees, clear out the complexities within the by-laws, and develop trust of the executive committee by council. These actions will cut the time to enact change and allow the council to be more effective in the areas where we can impact growth and profitability. There are by-law changes in consideration that will further accomplish these actions.

For current annual year-end, SPE results that net revenue for the society including the SPE Foundation was $243,000. These positive results will provide cash flow confidence as we continue with the IT system and website upgrades.

Another positive report came from Membership where the society has surpassed the 15,000 mark. This includes 106 new members gained from ANTEC Mumbai. Overall, 13% of new members are added through conference registration. The current membership distribution stands at 77% US and 23% non-US. The coming upgrades in the EVECTRA system will simplify membership application and renewals.

ANTEC 2013 was well attended with 1800 registrants and 525 technical papers. The Thermoforming Division presentations were on Monday morning and very well-attended. **An area of focus for our division should be to increase the number of thermoforming-related papers** and extend our presentation to a full day. If you have a technical paper or tutorials in mind please feel free to contact me for support.

The Thermoforming Division continues to be one of the primary sponsors for student ANTEC travel and awards. Speaking of awards, I was proud to pick up the Thermoforming Division's Gold Pinnacle Award for outstanding performance as well as the Communications Excellence award. Congratulations to Phil Barhouse our 2012 Division Chairman and Clarissa Schroeder our Communications Chairman for their hard work and dedication necessary to achieve these honors.

Roger C. Kipp

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