The Film & Coating Connection

"Spreading the News"

Issue #9 ***July, 2006***

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Wilcox joins Chevron Phillips Chemical as President and CEO

Ray Wilcox became president and chief executive officer of Chevron Phillips Chemical, effective April 1.

"I am delighted to be a part of Chevron Phillips Chemical," Wilcox said. "I look forward to working with the team and building upon the success of the company's first five years."

Wilcox most recently served as vice president of Chevron Corporation and president of Chevron North America Exploration and Production Company where he was responsible for managing Chevron's oil and gas exploration and production activities and its resource base in North America. He previously served as an executive with Chevron in both domestic and international roles and in upstream and downstream segments of the energy business.

Wilcox is a native of Connecticut and graduated cum laude from the University of Michigan in 1968, with a bachelor's degree in mechanical engineering. He is also an alumnus of the 1994 London Business School Senior Executive Program.

To hear more from Ray Wilcox or to learn more about Chevron Phillips Chemical's leadership team check out www.cpchem.com/enu/leadership_team.asp

Chevron Phillips Film & Coating Training Seminars

As a service to our customers, the Chevron Phillips Chemical Film & Coating Technical Service group offers Polymer 101 training.

The following topics are included in the 8-hour Polymer 101 seminar:

- Polymer Production & Polymer Chemistry
- Resin and Film Properties
- Film & Coating Extrusion Processes
- Converting Processes
- Polyethylene Market Details

The full Polymer 101 seminar can be customized to fit the audience and time constraints. Custom seminars are available which target specific audiences such as Operator/Technicians and

News about the people, products, and processes in flexible packaging.

The Film & Coating Connection
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Industry Events

FlexPO 2006 – The 11th annual conference on developments in polyolefins and elastomers will take place September 20-22 at the San Luis Resort in Galveston, TX. The theme for this year's conference is "Highlighting Growth Regions for the Future." Check out www.cmrhoutex.com for more information.

TAPPI PLACE – This year TAPPI celebrates the 60th year anniversary of the TAPPI PLACE conference. The PLACE conference will showcase the latest innovations in materials and equipment used in the fields of Polymers, Laminations, Adhesives, Coatings & Extrusion (PLACE). The PLACE conference will be held September 17-21 at the Hyatt Regency, in Cincinnati, OH. Check out www.tappiplace.org for more information.

PACK EXPO International – Pack Expo 2006 to be held October 29 thru November 2nd at McCormick Place, Chicago. It will focus on the latest developments in packaging technology and will showcase exhibitors' state-of-the-art advances in packaging machinery, converting machinery, materials, packages, containers, and components. Check out www.packexpo.com for more information.

Pira Smart Packaging USA – Pira's third annual Smart Packaging USA conference to be held January 25 & 26th at Wyndham Orlando Resort. This conference covers cutting edge technology and the latest developments in intelligent and smart packaging. Check out www.piranet.com for more information.

FlexPackCon – SPE's flexible packaging conference, FlexPackCon 2006 will be held December 14 -16 at the Renaissance Orlando Resort, Orlando, FL. This conference examines the latest trends in ongoing shifts in the flexible packaging industry. Check out www.4spe.org for more information.

Purchasing/Technical. The Operator/Technician seminars, lasting 2 to 4 hours, are focused towards processing conditions, processing issues and troubleshooting. The Purchasing/Technical seminars, lasting 2 to 4 hours, are focused on resin selection variables and end use properties.

Please contact your Chevron Phillips Film & Coating Technical Service representative for more details.

Extrusion Coating…Faster, Thinner & Improved Bond

Ever since the evolution of extrusion coating, one main objective or challenge has been to process at higher line speeds and lower coating weights without sacrificing bond strength or other critical properties. It is not uncommon to see extrusion coating lines being manufactured and designed today to run at speeds in excess of 2000 fpm.

The demands and expectations placed on a resin under these conditions are extraordinary. Polymer is heated at temperatures in excess of 600F in order to oxidize the polymer, but not degrade it, and then it is extruded in an unsupported air gap. It is then thinned down, in some cases to 1/150th of its original thickness in less than 25 milliseconds. The acceleration forces in this case are greater than going from 0-60 mph in less than 1/10th of a second. It is obvious that there are high demands placed on extrusion coating resins, particularly at high line speeds and low coating weights.

Chevron Phillips Chemical has a resin that meets these demanding requirements. MarFlex® 1019 LDPE extrusion coating resin is a 0.917 density, 16 melt index resin that is specifically designed to service the low coat weight, high line speed market. The rheological properties of this resin are optimized to provide an excellent combination of drawdown with minimal neck-in and stable melt curtain edges.

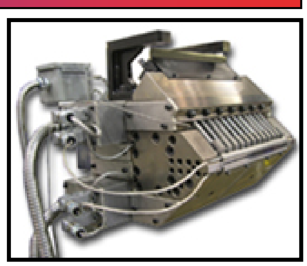
Another advantage of MarFlex® 1019 LDPE is its ability to wet out and penetrate deeper into a porous substrate to "anchor" into the "nooks and crannies" of the substrate providing increased mechanical bond, when compared to other lower melt index LDPE grades.

Keep in mind however, that the one disadvantage of using a high melt index LDPE is a slight increase in neck-in versus lower melt index LDPE resins. Ideally processors should match the melt index of the LDPE with the amount of drawdown required for the application, which is why Chevron Phillips Chemical offers a broad range of melt indices within our extrusion coating LDPE products.

To learn more about Chevron Phillips Chemical's extrusion coating products check out www.cpchem.com.

Featured Guest Article – Die Lip Sensitivity in Polymer Dies by Gary Oliver, Cloeren Incorporated

Different polymers and applications can each require a specific die opening or die gap. This change in die gap can present a unique set of challenges that the processor should understand to take advantage of this process change, and use it constructively to produce a high



Industry Glossary

Bond Strength – In extrusion coating, bond strength is a measurement of the amount of force required to separate individual layers that combine to make a complete structure. Bond is most commonly measured by using a tensiometer to separate the individual layers and the value is typically expressed in grams per inch.

Cohesive Bond Failure – A term used to describe the bond failure where the adhesive (primer, polymer, etc.) fails in a manner where it remains on both sides of the substrate and indicates a failure within the adhesive itself.

Chemical Bond – Bond strength produced by two substances being held together by the atoms of these substances sharing or exchanging electrons or electrostatic forces. In extrusion coating, chemical bonds are produced by pretreating, chemical priming, oxidizing the melt, ozonation, and by utilizing tie resins in blends and coextrusions.

Mechanical Bond – Bond strength produced by the wetting out and physical penetration and anchorage of one substance into another. In extrusion coating the molten extrudate is extruded onto a substrate. Depending upon the porosity of the substrate the extrudate will penetrate into the substrate and then as the polymer cools and solidifies it becomes anchored and mechanically bonded. Mechanical bonds are produced by using the nip pressure to drive the molten polymer into the substrate and mechanical bonds can be increased by increasing the porosity of the substrate and by decreasing the viscosity of the extrudate.

Processing Tips

"The Film & Coating Connection" is pleased to offer useful extrusion coating processing tips. However, due to the complexity of production and manufacturing, these tips should be used only as rough guidelines and suggestions. Implementation of any of these processing tips could affect the finished properties of the final product and should **never** be implemented without proper safety considerations. Further, they are not a substitute for your own expertise.

Guidelines for Setting Extruder Temperature Profile

Setting and optimizing the temperature profile of the extrusion system is critical to achieve optimal output and melt quality. Considerations of both the types of equipment and polymer must be taken into account when setting the temperature profile.

Starting with the feed section it is imperative that it has adequate cooling and that there is no blockage or obstructions in the feed throat. The outside of the feed throat (cooling jacket) should be cool enough that one can place and hold their hand on the surface. The coolant supply hose should also be on the lower portion of the feed throat jacket with the outlet hose on the upper portion of the feed throat to prevent starve feeding of the coolant. Adequate cooling in the feed throat will prevent premature softening and melting and will prevent bridging in the feed throat.

Next, the temperature should be set in the feed zones to start heating the polymer, but not to melt the polymer. The objective of the feed zone is again to feed and convey resin pellets. The softening and melting process is started just as the pellets move from the feed section of the screw to the transition or compression section of the screw. It is also important to note that the temperature zones that control the quality product. Chevron Phillips Chemical is excited to feature this informative technical paper, written by Gary Oliver of Cloeren Incorporated. Gary is a Senior Corporate Scientist for Cloeren Incorporated and has extensive knowledge in extrusion coating, coextrusion and die and feedblock technology.

Die designs for generating polymer coatings or films often include a flex lip for varying the geometry of the lip opening. The formation process requires die lip gaps ranging from 0.4 mm to 1.0mm. Flex lip gap and the adjustment of said gap becomes increasingly difficult to control as it is reduced. This technical paper examines the issue of die lip sensitivity with different polymers extruded at various lip openings.

Click here to view Gary's paper entitled "Die Lip Sensitivity in Polymer Dies."

New Gas Chromatograph-Mass Spectrometer at Orange Customer Service Laboratory

Chevron Phillips Chemical's Orange site recently purchased a new Gas Chromatograph-Mass Spectrometer (GC-MS). This is designed to address the needs of the manufacturing facility through improved quality control as well as improved service for our external customer needs through the Customer Service Lab (CSL).

GC-MS is a testing method that combines the features of gas-liquid chromatography and mass spectrometry to identify different substances within a test sample. Applications of GC-MS include drug detection, fire investigation, environmental analysis, explosives investigation, and in-depth analysis of additives and investigations for the polymer and packaging industry.

The use of a mass spectrometer as the detector in gas chromatography was developed during the 1960s. These sensitive devices were huge, technique oriented, and limited to laboratory settings. The development of affordable and miniaturized computers has helped in the simplification of the use of this instrument, as well as allowed great improvements in the amount of time it takes to analyze a sample. This has also allowed these instruments to be introduced into smaller labs with wider applications. For Chevron Phillips Chemical, this translates into broader applications to better serve our customers' needs.

For those not familiar with the technical workings of a GC-MS, they are composed of two major instruments: the gas chromatograph and the mass spectrometer. The gas chromatograph uses the difference in the chemical properties between different molecules in a compound to separate the molecules. The molecules take different amounts of time (called the retention time) to come out of the gas chromatograph. This allows the mass spectrometer downstream to evaluate the molecules separately in order to identify them. The mass spectrometer does this by breaking each molecule into ionized fragments and detecting these fragments using its charge to mass ratio. Each molecule has a specific fragment spectrum which allows for its detection. Using these two instruments together allows for a much finer degree of substance identification than either unit used separately. Also the availability of ion libraries on the new instruments and the sophistication of the new software for these instruments have greatly enhanced the ability of spectroscophers to identify low level contaminants with a high degree of accuracy.

The GC-MS is a new addition to the CSL and not yet developed to its full capabilities, but that is only a matter of time. This instrument will

feed sections are typically located just after the feed throat and not just below the hopper. Therefore, setting these zones at a temperature setting above the melting point of the polymer does not mean that melting will occur just below the hopper, causing bridging. It is common to set the feed zone sections above the melting point of the polymer. The cooled feed throat, combined with a low residence time in the feed sections, will typically prevent the polymer from melting in the feed throat and the feed zone.

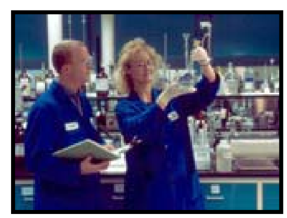
In the next zone of the extruder, the transition or compression zone, the temperatures should be set to melt the polymer as the pellets are being compressed, removing air and volatiles from the resin. If the temperatures are set too high in the rear of the compression zone then melting may occur prematurely entrapping air and possibly creating voids. However, there should be sufficient heat generated in this section to melt most of the polymer as it exits the transition zone and enters the metering section.

In the last section of the extruder, the metering zone, the temperatures should be set to the desired melt temperature. Providing that the screw has generated sufficient frictional energy and heat, and that the temperature zones in the feed and transitional zone are set correctly, then the melt temperature of the polymer in the metering zone should be at or near the desired melt temperature. The job of the metering zone is to pump a consistent volume of polymer and possibly provide some additional mixing if a mixing zone is utilized in this zone.

It is then important to maintain a constant melt temperature from the end of the extruder to the exit of the die and not to attempt to add or remove heat from the polymer downstream from the extruder. If heat is added or removed in any downstream areas (pipes, adaptors, die, etc), then there is no method to mix or homogenizing the melt stream, with the exception of using a static mixer in the system.

Optimizing temperature profile in an extrusion system will ensure a constant and steady throughput of polymer melt at the desired melt temperature required to produce a quality product.

Quality Corner



Quality as defined by Webster is "superiority in kind." Specifically, the product or service offered by one manufacturer or service provider is superior to all others offering a similar product or service. In the last fifty years, there have been volumes written on the subject of quality, and no two books define quality the same way. Some focus on fulfilling requirements, others on fitness for use, and still others on conformance to specifications; however, the key element in quality is the customer.

Quality is how well a product or service meets or exceeds the needs and expectations of the customer. In order to accomplish this, the customer's needs and expectations must be known. Knowing the customer's needs and expectations can be achieved through the use of marketing surveys, customer feedback, or focus groups. Actively soliciting customer information is fundamental to the long-term success of any business enterprise.

enhance the CSL's ablity to help solve customer problems as they arise. One area should be in identifying surface contaminants. Along with FT-IR, the GC-MS should greatly enhance this capability. Also, in the area of identifying odor-causing compounds, the "headspace" accessory coupled to the mass spectrometer should greatly improve our precision on these usually volatile and elusive components.

Seven Chevron Phillips Chemical Facilities Earn VPP Star Among Stars "Star of Excellence" Award

At the recent Occupational Safety and Health Administration (OSHA) Region VI Voluntary Protection Program (VPP) conference, seven Chevron Phillips Chemical facilities received the distinguished Star Among Stars "Star of Excellence" award. The award is the highest honor bestowed on VPP Star sites.

The facilities honored include Chevron Phillips Chemical's:

- Bartlesville Research and Technology Center in Bartlesville, Oklahoma
- Borger Plant in Borger, Texas
- Drilling Specialties Alamo Plant in Conroe, Texas
- Headquarters in The Woodlands, Texas
- Kingwood Research and Technology Center in Kingwood, Texas
- Performance Pipe Brownwood Plant in Brownwood, Texas
- Port Arthur Plant in Port Arthur, Texas

"OSHA's Voluntary Protection Program was designed to recognize worksites with exemplary safety and health programs and identify facilities that serve as a benchmark for others in safety performance," said Greg Hanggi, Vice President of Environment, Health and Safety. "At Chevron Phillips Chemical, we believe in the basic principles of VPP: compliance, participation, leadership and continuous improvement," he added. "The fact that seven Chevron Phillips Chemical facilities were honored with the top recognition among the elite VPP Star sites is outstanding. It shows the commitment these sites have to going beyond compliance to making safety awareness and safety improvement daily activities for all of their coworkers. Way to go!"

Company-wide, Chevron Phillips Chemical has lowered its recordable incident rate by more than 70 percent since the company's formation and more than half of its facilities were injury-free in 2005.

"I am very proud of this recognition," said Ray Wilcox, President and CEO of Chevron Phillips Chemical. "Our employees at these seven facilities achieved zero injuries and incidents in 2005 to achieve the Star of Excellence, demonstrating that safety truly is our culture at Chevron Phillips Chemical."

OSHA established VPP in 1982 as a premier partnership with labor and management. Of the six million eligible facilities in the U.S., approximately 1,200 have achieved the prestigious VPP Star. The Star of Excellence is presented to VPP Star sites with injury incident rates at least 90 percent below the Bureau of Labor Statistics national average. Currently, 360 facilities within OSHA Region VI are VPP Stars with 101 sites receiving the Star of Excellence for 2005.

The second key element in quality is that quality is everyone's responsibility. From the CEO to the worker, creating quality products and services is up to everyone and has benefits for everyone. These benefits of quality range from better goods and services for the customer to greater profits for the company to more job security for the employee. For every company, the formula for success starts with quality.

Internet Resources

Chevron Phillips Chemical's eService Center – The Chevron Phillips Chemical's eService Center uses a web interface to provide round the clock, real time access to customer data. Take a tour of the eService center at www.cpchem.com to find out more detailed information.

IDES The Plastics Web – IDES The Plastics Web, is a search engine, similar to Google. However, results from the search engine are narrowed down to only plastics-related items. For example, a search for nylon on Goggle may result in millions of hits, including everything from the history of nylon stockings to nylon items for sale on e-Bay. The IDES search however will pertain specifically to plastics-related websites, narrowing the results to a few thousand plastics-related hits. Check out www.ides.com for more information.

Important Contact Information

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ext. 6315 Kelly Frey – Extrusion Coating Tech Service
ext. 6391 Darrell Landry –OSP® Systems and Ext. Coating TS
ext. 6136 Doug Mills – Film Tech Service
ext. 6193 James Solis – OSP® Systems and Film TS
ext. 6126 Connie Sonnier – F&C Admin. Assistant
ext. 6322 Larry Szmutko – Film Tech Service
ext. 6156 Rick Wagner – Film Tech Service

Polypropylene Film & Coating Technical Service
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K-Resin® SBC and Polystyrene Film Technical Service
(740) 374-0262 Jack Frost

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DIE LIP SENSITIVITY IN POLYMER DIES

Gary Oliver, Cloeren Incorporated, Orange, Texas, USA

Abstract

Die designs for generating polymer coatings or films often include a flex lip for varying the geometry of the lip opening. The formation process requires die lip gaps ranging from 0.4 mm to 1.0mm. Flex lip gap and the adjustment of said gap becomes increasingly difficult to control as it is reduced. An examination is made of the issue of die lip sensitivity with different polymers extruded at different lip openings.

Introduction

One of the desirable attributes of lamination or coating is coat weight uniformity and or product flatness. While internal flow geometry of coating or film dies can theoretically be designed to give uniform flow across the width of a die, the related design calculations and their precision are dependant on the accuracy of not only the flow models themselves, but also the data input into flow models (1), and the consistency of the physical properties of the polymer or composite being processed. Because in application isothermal conditions rarely exist, and polymer temperature and viscosity uniformity are rare, film and extrusion coating dies incorporate a flexible lip to enable adjustment of the exit geometry for final flow balancing.

Background

Various geometries and cross sections are incorporated to increase or decrease die lip flexibility. The flexibility of the lip beam and the spacing and coupling of lip adjustment bolts are important features to insure die gap precision and adjustability. Die bolt coupling, or the impact a single bolt has on adjacent areas of a flex lip, varies from 37mm to 150 mm depending on lip beam design. Lip adjustment bolt spacing has long been an area of interest. Egan Davis Standard, for example established a standard 50 mm die bolt spacing on automatic dies. Extrusion Dies Industries established a standard of 28.6 mm. Cloeren Incorporated established a standard of 25 mm. While this subject is important in overall flatness or uniformity of coating, the issue of die bolt spacing and coupling will be addressed at another time.

Variables in mass flow calculations, in addition to geometrical details, include pressure drop and the viscosity of the polymer flowing through the slot (2).

$$Q := \frac{1}{12 \cdot \eta} \cdot \frac{\Delta P}{L} \cdot W \cdot h^3$$

With the shear thinning behavior of polymers, the impact of shear rate and its resultant impact on melt viscosity must be considered in final die design. As a lip gap decreases, the shear rate increases, and thus there may be a decrease in viscosity, impacting the differential pressure across the die lip. While the calculation itself is an iterative process with the above mentioned viscosity changes from differing lip gaps, for the purpose of these evaluations we will assume isothermal conditions, and examine the pressure drop component in and of itself as an indicator of die lip sensitivity.

$$\Delta P := \frac{12 \cdot \eta \cdot Q \cdot L}{W \cdot h^3}$$

Monolayer and coextruded coatings and films are often produced using polymers with diverse viscosities and shear thinning behaviors. Each of the said polymers will respond differently to lip adjustment. For a given a die slot opening, we will examine the impact of adjusting lip gap, (h), on the pressure drop across the die lip. Further examination will be made of the impact of these adjustments on different polymers.

As the die gap decreases, the response to change can increase dramatically. This effect makes adjustment of the lip gap more difficult at reduced lip openings, as is the case in instances where draw down ratio must be minimized in materials susceptible to draw resonance (3,4).

The lip adjustment system on a flex lip die generally consists of a bolt or threaded member that pushes on a translator or the die lip itself closing the lip gap. An adjustment mechanism with coarse adjustment can provide up to 1 mm of movement in a 360º rotation of the adjustment bolt. Finer adjustment is achieved with a differential thread system, resulting in 0.2 mm per 360º rotation of the bolt. In addition to the axial movement of the lip adjustment bolt, depending on the mounting angle, there is amplification between the lip adjustment assembly and the resultant lip gap displacement of approximately 1.5. This combination of adjustment mechanics means that a quarter turn

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of a die lip adjustment wrench can provide from 0.08 to 0.4 mm of lip gap change depending on which manual adjustment mechanism is involved. Given the magnitude of change possible in pressure drop across the die lips with minimal manual adjustment, film and coating dies are sometimes described as "jumpy" when a technician attempts to adjust the profile.

Traditionally, finer adjustment of the lip gap on a die has been accomplished through automatic profile control (APC). Standard operating procedures require establishing a uniform lip gap across the width of a die. Upon initiation of APC, the gap is automatically adjusted, while maintaining a uniform average lip gap. That is to say, for every area where the gap is closed, an equivalent amount of opening must occur in another area of the die, thus maintaining a uniform exit area. In an automatic profile control system, the lip adjustment is often accomplished through a thermal translator. This translator is heated and cooled to provide varying degrees of elongation. Depending on the materials of construction, the means of heating the translator and the length of the thermal translator, the range of motion is applied to the die lip and as such the gap is changed. The same amplification between lip adjustment or translator movement observed in manual adjustment devices applies to automatic lip adjustment. The effected lip gap change is therefore 1.5 times greater than the elongation of the thermal translator. A balance must be accomplished in the compressive strength of the thermal translator and its properties regarding coefficient of thermal expansion. Some materials while exhibiting high expansion coefficients and exceptional free air elongation do not possess the compressive strength to translate the elongation to lip movement. As a result the translator yields to the opposing forces created by die lip pressure and the net resulting elongation is minimized or negated. If a design is robust enough to provide a large net elongation under load, this longer translator or a more expansive translator is not always advantageous, and can often be deleterious. Balance must be achieved between functional lip opening, range of motion of lip actuators, and variations in polymers processed in an extrusion coating die.

Conclusion

Given the sensitivity of the pressure drop across the lips of an extrusion coating die with reduced lip gap, minimal lip movement is necessary to balance flow in an extrusion coating die. The finest adjustment possible or an adjustment with less range of motion will provide the maximum resolution and the most desirable adjustment method for the ultimate film flatness.

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