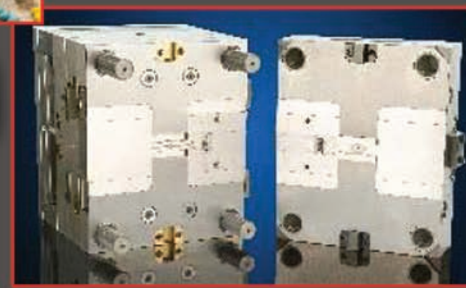
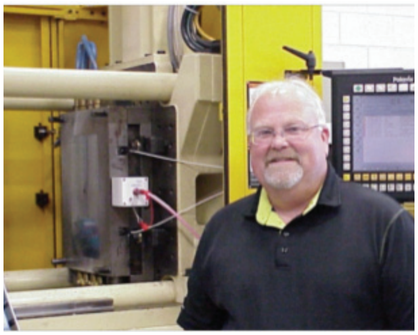
Spring 2016 | No. 101



MOLDING VIEWS

Brought to you by the Injection Molding Division of the Society of Plastics Engineers

Chair's Message



IMD Membership & Fellow SPE Colleagues,

I hope everyone is having a great 2016 and that you made a commitment to do everything this year better than last. As one of this year's resolutions, I hope you will be attending ANTEC 2016 this coming May 23rd through May 25th, in Indianapolis, Indiana. The IMD Board of Directors is focused on providing great ANTEC content and is once again proud to offer seven sessions of our own (with one of the seven being a tutorial) plus a joint session with the Mold Technologies Division. The seven IMD sessions will cover simulation, materials & microcellular foams, processing, process troubleshooting, and emerging technologies; all-in-all, there are close to fifty technical papers/presentations for your enjoyment. If you do make it to Indianapolis, don't forget to attend the IMD ANTEC 2016 Networking Reception on Tuesday May 24th, starting at 6:30 pm. The IMD reception is a great place to share your "war stories" with several hundred colleagues from industry and academia as well as visit the exhibit tables of the Division's Gold and Silver Sponsors.

In This Issue:

This Month's Features:

Chair's Message Continued

Speaking of sponsors, I would like to take this opportunity to personally thank our 2016 Gold Sponsors – **Autodesk**, **Master Precision Mold Technology**, and **Tupperware Brands Corporation**; our 2016 Silver Sponsors – **DRS Industries** and the **SPE Detroit Section**; and our 2016 Bronze Sponsors – **Beaumont Technologies** and **Sigmasoft Virtual Molding**. The IMD would not be able to provide technical content and networking events to our membership if it were not for the generous contributions of our sponsors; so again, to all of our sponsors – thank you!! Sponsorship opportunities are still available in 2016. Please contact me directly to discuss any one of several levels of sponsorship as well as other opportunities where you can make a difference; you can find my email address on the IMD website (http://injectionmolding.org/).

Finally, I mentioned in past messages that the IMD Board of Directors was in the process of forming strategic partnerships with other SPE Divisions and Sections so as to participate in new or existing TOPCONs and Minitecs. I'm very excited to announce that the IMD has partnered with the Detroit Section and the Automotive Division to provide technical content to the 2016 AutoEPCON Conference; check it out at https://www.eiseverywhere.com/ehome/143053. Look for future IMD partnerships and conference opportunities on our website as well as this newsletter.

Best regards to all,
David A. Okonski
IMD Chair & Staff Engineer, GM Global R&D Center

Industry Events Calendar

Click the show links for more information on these events!

MARCH 2016

MARCH 29-31

Shape Extrusion Topcon
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4spe.org
The event where you'll learn the theory and tricks of the trade to make high-precicion extruded products.

APRIL 2016

APRIL 18-20 2016

Thermoset Topcon
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The Thermoset Division's annual conference unites industry suppliers, material manufacturers, mold and part designers, processors and OEMs in a technical forum which highlights the most contemporary advancements in material, machine and application technologies. The two day, casual conference is held in combination with exhibits and exclusive networking opportunities.

APRIL 19-21

Bioplastic Materials TopCon and Tutorial
Bloomington, Minnesota
4spe.org

APRIL 19-21

MC2 Conference
Dallas, Texas
icdallas.com

APRIL 25-27

ReFocus Recycling Summit & Expo
Orlando, Florida
4spe.org
Re|focus is 2.5 day summit and exposition designed by the industry and for the industry. The educational program will focus on the environmental challenges companies face in their supply chains and product design processes. Featured discussion topics include the use of recycled content, design for recycling, the pursuit of zero waste in manufacturing, and the cutting edge technologies that are allowing broader recovery of plastic products.

MAY 2016

MAY 23-25

ANTEC 2016
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4spe.org
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JUNE 2016

JUNE 5-7

2016 SPE Decorating & Assembly Division Topical Conference and IMDA Symposium
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http://www.plasticsdecorating.com/topcon/2016/
The SPE Decorating & Assembly Division will be conducting its 2016 Topical Conference (TopCon) in conjunction with the 2016 In-Mold Decorating Association Symposium.

JUNE 15-16

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Injection Molding Division

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INJECTION MOLDING DIVISION

Sponsorship Levels & Sponsorship Agreement

The Injection Molding Division (IMD) is the largest single entity within the Society of Plastics Engineers; we have just over 3,000 active members — professionals working in the industry as well as academia — who care about and are concerned about the future of plastics. IMD membership promotes the responsible growth and use of plastics, and the IMD rigorously supports this initiative through education and innovative technical programming. IMD sponsorship monies help this Board fund: 1) community outreach programs that educate the masses about the many aspects of plastics, 2) technical programming such as TOPCONs, Minitecs & webinars, 3) student projects/activities at universities such as Penn State (Erie), Ferris State & Western Michigan, and 4) the ANTEC IMD Networking Reception. I have never been more excited about the future of the IMD. Don't miss this opportunity to be a part of the excitement. Please become a sponsor of the Injection Molding Division – sponsorship opportunities are listed below.

Thanks for your consideration,
David A. Okonski
IMD Chair / IMD Sponsorship Co-Chair / Staff Research Engineer, GM Global R&D Center

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Webinars

How the "Internet of Things" can optimize your productivity and decrease your downtime on your Molding Machine

Today, full scale online diagnostics and remote service allows equipment suppliers to help molders:

• Reduce down time during trouble shooting • Increase productivity • Increase part quality • Identify defective machine parts before technicians arrive • Monitor machines remotely, and tune machine parameters (service values) to keep equipment running until service arrives with parts Industry 4.0, the "Internet of Things" and similar technologies take this to another level. They allow the IMM to "talk" to the peripheral equipment and ideally, allow them to be serviced remotely through the IMM. Through live demonstrations we will show that all the above is already reality.

Copper Alloys for Injection, Thermoform and Blow Molds

After diamond and silver, copper is the most thermally conductive of the elements. In it pure form, copper is not strong enough to be using as a mold material. However, by alloying copper, it can be made as strong as steel while retaining much of its thermal conductivity. This webinar will focus on the various copper alloys used in the plastic molding industry and identifying the strengths and weaknesses of each. Primary topics (what the registrant will learn):

• How copper alloys differ from steel in plastic molding

• How copper alloys can improve the plastic molding process

• The characteristics of copper alloys vs. steel

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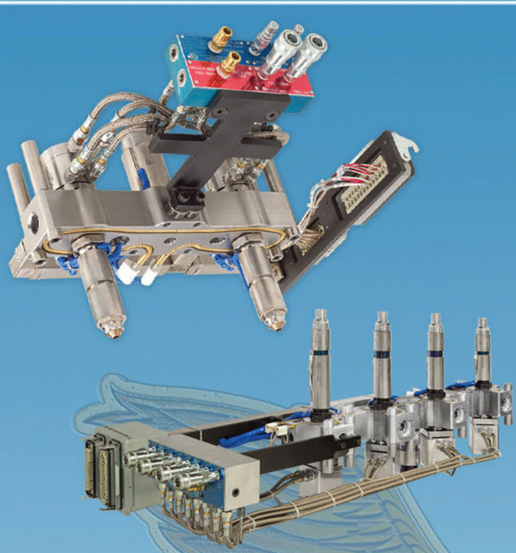

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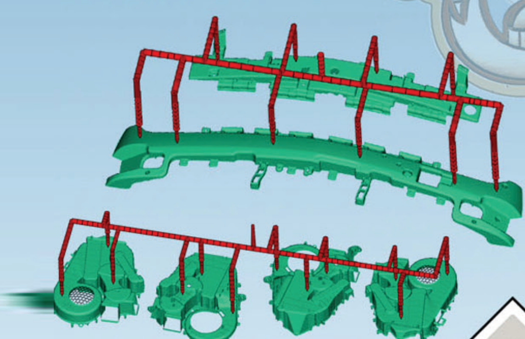

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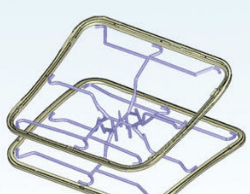

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Can Composites be Inection Molded?

Bob Dealey, owner and president of Dealey's Mold Engineering, Inc. answers your questions about injection molding.

Bob has over 30 years of experience in plastics injection-molding design, tooling, and processing.

You can reach Bob by e-mailing molddoctor@ dealeyme.com

Q: We purchase all of our injection molding products from custom molders. Due to past history of high quality and on time deliveries out supply base is rather small, but each molder has specialties that meets our typical requirements. A new project requires a composite part. None of our supplies have experience injection molding composites. My question is: "Can composites be injection molded?"

A: Due to very limited information regarding the material, I expect a long answer and hope it helps.

First the ASM, Volume One, Composites International Handbook defines "Composite Material": "A combination of two or more materials (reinforcing elements, fillers and composite matrix binder), differing in form or composition on a macroscale. The constituents retain their identities; that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another."

By that definition, a glass (mineral, fiber or other reinforcement) thermo plastic material can be considered a composite. These types of plastics are molded everyday by almost any injection molder.

We also know that injection molding is not limited to thermoplastic materials. The injection molding process has been utilized with thermoset plastics, metals, concrete, roofing tar, chocolates and a host of other materials.

A common type of composite is molded utilizing a prepreg mat of material and probably the material you are asking the question about. "Perepreg" is

Ask the Experts: Bob Dealey Continued

defined by ASM as: "Either ready-to-mold material in sheet form or ready-to-wind material in roving form, which may be cloth, mat, unidirectional fiber, or paper impregnated with resin and stored for use." These materials typically are processed by hand layup into an open mold and then the mold is placed into an Autoclave to cure the thermosetting material, commonly an epoxy. However, other molding concepts are utilized, with resin transfer an option.

I realize that you would like to stay with your present supply chain and it provides a certain comfort level. However, if they are not equipped or experienced in the process you product requires, it might be in your best interest to locate a new supplier.

I understand that a company in Duluth MN, Clearwater, has successfully injection molded prepreg materials and might be someone you could contact.

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By Brenda L. Clark, HASCO America, Inc., Fletcher, NC

Fundamentals of Optimized Mold Cooling System Design for Injection Molds

Mold cooling has evolved, just like mold machining has required faster machining, new mold cooling components are increasing efficiency of required mold cooling. Advancements through the years as specialized material selections for cooling components, conformal cooling inserts, and back again to components utilizing standard machining practices. There are new mold cooling components used to reduce machining time by reducing mold component lengths and therefore shortening plate thickness. Historically mold cooling was designed to circulate water or cooling medium through the mold base plates primarily and not necessarily within the cavities or cores. This practice usually required many different levels of cooling lines and thicker mold plate assemblies. The newer advancements create a circulation that is now optimized within mold plates and specialized within the cavities and cores to reduce mold heights.

Introduction

The one aspect of efficient cooling design that has not evolved is to place the proper location and sizing of cooling lines within mold base plates and cavity/core inserts. The discussion here is based on the need to remove the heat from the cavity, core, or mold plate using cooling lines with a cooling medium or fluid. While there are also applications for specific plastic materials to have the cavity, core or mold plates heated to set up or cure the article properly using heated oil or heater cartridges this is not fully addressed within the scope of this paper.

Cooling of mold plates and inserts can range from hot to cool, mold assemblies typically may run anywhere from 40°F to 320°F (4°C to 160°C).[1] Keeping cooling at a proper distance from parting line and article or part that is molded is the first key in creating the best possible product and molding process. The second key is the sizing of the cooling line diameter should be large enough to overcome the heat convection of the plastic material temperature that transfers into the surrounding steel. The third key will be the metal material that the mold plates and cavity/core inserts are manufactured from in relation to the conductivity factor. The forth key is the need for a turbulent flow to assist in removal of the maximum amount of heat from the metal.

Safety Note

The most important safety feature to mention is that all the supply and exit cooling lines should always be on the bottom and/or non-operator side of a mold when running in a molding machine. This is not only to keep the operator safe, but to also allow any electrical connections for items like hot runner control connections to remain high, dry and safe in the production environment.

Feature: Optimized Mold Cooling System Design Continued

Sizing Cooling Systems

Drilled and gun drilled mold plate cooling lines are machined on single and multiple levels to achieve desired cooling within a mold assembly. Pitch locations of these waterlines along the plan view should be between three to five times the cooling line diameter measurements. With a distance of one to two times the cooling line diameter measurement from the parting line to the first level and the same distance between each additional level relative to the plate thickness. This adds additional steel requirements to the plate thickness and increases the overall mold height. Diverters can also be installed in line on different levels to assist movement of cooling medium in specific directions through the cooling system lines to cool the mold assembly properly. General sizes for mold cooling lines in mold base plates are: (but not limited to) 5 mm, 8 mm, 13 mm, 1/4, 5/16, 7/16 and 9/16 diameters.

Another critical consideration is cooling lines should never be at a distance under 3.18 mm (0.125 inch) when measuring from the cooling line wall to molding article or part wall surface or to an insert split line. Never leaving a thin steel condition between insert split lines and cooling lines, as the life of the mold will be jeopardized.

Cooling System Set-up

There are numerous products on the market to accomplish the proper cooling set-up in your mold design. Some of the tried and true cooling components are baffles requiring one waterline with supply line installation at 90° to direction of flow, bubblers using two waterlines creating separate supply and return lines, Isobar or cooling pipes which sometimes are also called heat pipes using one cooling line with direct cooling medium contact to transfer the cooling temperature up to a specific concentrated location within a cavity/core.

The spiral cooling cores require separate supply and return lines and have single and double thread options to direct cooling. The cooling medium will follow the thread path in a specific direction. The single spiral thread version has the supply circulate up around through the threads and the return then down through a central hole. The double spiral thread version has both the supply up and return down circulating separately through the threads and does not require the return to use a central hole. There is also standard o-ring, diverter plugs and water jackets that wrap around core inserts these are all parts of basic cooling components that have been incorporated into mold designs for decades.

Today there are cooling products on the market such as the conformal cooling inserts, the flexible cooling element, and specialized o-ring type diverters. The flexible cooling element is a newer option for mold plate cooling that is a stainless steel metal flexible square corrugated walled tube with quick disconnects on both ends. This element is pressed into a machined channel installed into a mold plate. The flexible cooling line is installed into a milled channel that is coated with a copper paste for ideal heat transfer. The element may be installed into new designs or incorporated into existing molds that are experiencing hot spots or uneven cooling and require additional direct cooling lines. The flexible cooling line is used between two plates that are screwed together, but may also be used in floating plates as long as aluminum straps are used to insure that the element stays within the mold plate it is installed into when the mold is functioning under movement.

Newest Cooling Component

The newest unique o-ring type diverter cooling item the Z99/… CoolCross a HASCO exclusive product (further called a cylindrical insert) allows for the first time waterlines to cross while being drilled on the same plane. This allows for the cooling lines to surround all four (4) sides of a cavity/core and promote an even temperature distribution within the system without expensive additional machining. Now it is possible to achieve cooling flow completely surrounding each cavity/core and on a single level or plane within a mold base plate or insert. No more need for mold assemblies using multiple levels with thicker plates or higher die heights.

The cylindrical insert is a glass filled nylon plastic insert with a Viton o-ring on the outer diameter that is placed into a mold plate specifically where two 8 mm (or 13 mm) diameter drilled waterlines intersect. The cylindrical insert has a separate channel and a separate path that crosses and do not allow the cooling medium flow to mix directions. The first elongated channel passes through the diameter while a path passes up and over the first channel still allowing the cylindrical insert to be low in profile. The channel and path are calculated for maximum volume passage with an 8 mm (or 13 mm) diameter cooling line.

The cylindrical formed hole is machined into the back of a mold plate or cavity/core insert to a desired depth, similar to the thickness of the cylindrical insert. The formed hole has an additional specific shape which keys to align the cylindrical insert in relation to the two intersecting drilled cooling lines to prevent rotation during use. Care should be taken when machining to make sure the desired flow direction is achieved and the specific shape and key are aligned properly. The cylindrical insert is installed with the o-ring seal closest to the entrance of the cylindrical formed hole, allowing a complete seal. When the level of the intersecting cooling lines is required to be deeper than the thickness of the cylindrical insert an adapter Z9901/… is required. The adapter is adjusted by cutting to the proper length and installed after the cylindrical insert is inserted into the

Feature: Optimized Mold Cooling System Design Continued

deeper cylindrical formed hole. The adapter will position the cylindrical insert at the proper level to align the flow paths with the drilled cooling lines.

Figures and Descriptions

The K or metal material conductivity factor in discussion here has a designation of BTU/Ft•h•°F or W/m•°K. This K factor is lowest in stainless steel (K = 13.2 or 23), meaning the stainless steel will not transmit heat as fast as say a higher K factor material conductivity like pure copper (K = 174.5 or 302). It is best to choose the specific metal material for the specific application, the first formula for conduction will show the best conduction material solution for a project. A cavity or core is retaining too much heat when in the molding process and the cooling medium cannot overcome this heat a bronze or beryllium copper insert can be substituted in place of the metal material as a direct replacement to reduce the heat buildup. This replacement can be either the whole cavity or just areas within a cavity that are inserted as a different metal material.

To increase convection is to produce a turbulent flow within the cooling lines by pushing the cooling medium faster. This is shown in the following convection calculation as velocity and time that the cooling medium is within the system. Higher, faster flows will help to eliminate any possible hot spots or dead areas within the system allowing the water to tumble through the cooling line and remove the maximum amount of heat from the steel. Important is also to remember that a fluid will continuously pass to the path of least resistance. To insure a turbulent flow in a circuit use of a flow meter will best determine if the flow is actually turbulent or laminar. Each circuit within a mold assembly should have their own supply inlet valve for ideal set-up adjustment to achieve turbulent flow.

The heat transfer from the steel into the cooling medium to overcome the increase in temperature is what is required to assist in cooling and curing the product that is being molded. There are two forms of heat transfer calculations that need to be addressed. Conduction, or transfer from plastic to metal material, and Convection, or transfer from steel to cooling medium. Both are calculated as shown here to result in BTU or the amount of energy needed to cool or heat one pound (0,454 kg) of water by one degree Fahrenheit (0,56 °C) at a constant pressure of one atmosphere. [2]

Calculations

The formula for conduction calculation or Fourier's Law [3] is as follows:

$$H = \frac{KAT(t_2 - t_1)}{L}$$

Where H is the heat transfer (BTU, J), K is the metal material conductivity factor (BTU/hr°Fft^2/ft, W/m°C), A is the area of the cavity/core in contact with the melted plastic (ft^2, m^2), T is the cycle time per shot (hr), t2 is temperature of the melted plastic (°F, °C), t1is temperature of the cooling medium (°F, °C), L is the distance from the molding face to the edge of the cooling diameter hole (ft, m).

Feature: Optimized Mold Cooling System Design Continued

While the formula for convection calculation or Newton's Law of Cooling [4] is:

$$H = ms(t_2 - t_1)T$$

Where H is the heat transfer (BTU, J), m is weight of cooling medium (BTU/ft^2hr°F, W/m^2•°C) or (area of passage diameter A x velocity of cooling medium V x hours of curing time Ts x specific gravity sg), s is heat transfer area of the cooling medium (ft^2, m^2), t2 is temperature at the inlet of the mold (°F,°C), t1 is temperature at the outlet of the mold (°F,°C), T is time that the cooling medium takes to circulate (hr).

Discussion

The traditional experienced mold design cooling formulas are now being confirmed with the newest cooling analysis design software. This cooling software works on the same principle and calculations using these cooling requirement formulas within the back ground programming. The software takes into consideration the calculations but also uses the 3D data of the article to be molded and the 3D data of the mold design to predict the expected mold process temperatures and cooling requirements. Working with the cooling analysis design software will highlight possible hot spots or uneven cooling. This software will assist designers further to building the proper mold cooling systems by placing cooling lines closer, or farther away, or changing the cooling system pattern completely to achieve the correct final molding process.

Conclusions

Designer or design teams need to cover the known design recommendations for each specific application such as mold and molding materials. The steel for the mold plates, steel for the inserts as well as the plastic material and the article or part geometry that is being processed will govern cooling requirements. Calculations for optimization of cooling should be run either by manual calculations or with the newest software. Seeking out new components to minimize plate thickness, minimize hot spots in cavity/cores, reduction of machining time and costs to achieve the optimized cooling cycle time for each application is the key in an efficient mold cooling system. These components that have been discussed in this paper can be utilized into new mold designs as well as be incorporated into repair on any existing mold.

References

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2. Wikipedia: http://en.wikipedia.org/wiki/British_thermal_unit
3. The Engineering ToolBox on-line webpage: http://www.engineeringtoolbox.com/conductive-heattransfer-d_428.html
4. The Engineering ToolBox on-line webpage: http://www.engineeringtoolbox.com/convective-heattransfer-d_430.html

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Induction Heating Simulation for the Plastic Injection Molding Process

Injection molding technology now relies on in cycle variable mold heating and cooling in order to improve the surface finish and general part quality without increasing cycle time. Induction heating has the potential to be the most efficient method for heating specific areas of the mold quickly. Induction heating results in a non-uniform temperature distribution concentrated in the surface skin of the mold body touching the part. Simulation of induction heating offers the mold designer an insight into the mechanisms of induction heating before investing in this technology. This paper describes the development of a 3D finite element based electromagnetic solver that is used in the Autodesk Simulation Moldflow transient mold cooling solver. The derivations of the relevant equations are explained as well their effects on the mold during heating. Induction heating is then demonstrated on a real world model.

Introduction

Plastic injection molding is one of the most popular manufacturing processes for mass production. In order to obtain cost effective high quality parts consistently, many molders turn to simulation technology for part and mold design. Simulation technology aims to provide the analyst with accurate mold cooling, filling and part warp results to guide their design decisions.

Traditional injection molding design aims to maintain the mold at a constant temperature for the entire injection molding cycle. In order to achieve this, coolant is pumped through the mold cooling channels with constant inlet temperatures[1].

New molding technologies described variously as “Rapid Heating and Cooling”, “Variotherm” or “Rapid Temperature Cycling” varies the temperature of the mold during the cycle. The aim is to have a mold cavity surface temperature close to the melt temperature during the mold filling stage and to reduce the surface temperature to the ejection temperature during the packing and cooling stages of the injection molding cycle to reduce cycle time.

The high mold cavity surface temperature during filling, results in significantly less visible and stronger weld lines in the finished part. Weld lines are inevitable when holes or grills are present in the part or if parts are filled by conventional multi-gated runner systems. Visible weld lines weaken the aesthetic appearance of the

Best Paper: Induction Heating Simulation Continued

part and can significantly weaken the part structurally as well, especially for fiber filled materials where the fibers do not bridge the weld.

The high mold cavity surface temperature during filling results in high gloss surface finishes of plastic parts avoiding the need for other post molding surface enhancements such as polishing and painting. A hotter mold during filling, results in lower injection pressures. Lower injection pressures allow molded parts to have reduced wall thicknesses and give the molder more choice in relation to gating position, all of which reduce cost.

The benefits of rapid heating and cooling processes are particularly favorable when molding clear components such as lenses and flat screen television housings among other components.

Various rapid heating and cooling technologies use different methods of achieving the same outcome of a hot mold during filling. The most common heating methods considered are saturated steam, electric cartridge and pressurized hot water heating [2]. These methods are widely used in industry and have been reported on before [3]. The disadvantage of these traditional methods is that they have higher cycle times leading to lower productivity. The density of the heat flux is very low resulting in large areas of the mold heating up which have to be cooled again within the same cycle. Steam and hot water are also considered to be hazardous materials in the factory from a health and safety point of view.

Electrical induction heating allows for lower cycle times due to the precise control and positioning of the heat flux density and rate within the mold. The purpose of this paper is to describe the electrical induction heating process, its application to injection molding and the process by which it can be simulated.

Best Paper: Induction Heating Simulation Continued

Electrical Induction Heating

Electrical induction heating is a complex combination of electromagnetic, heat transfer and metallurgical phenomena [4]. The electromagnetic phenomena occur when a rapidly alternating voltage is applied to an induction coil. The alternating voltage results in an alternating source current in the coil. The alternating source current produces a time variable magnetic field within its immediate surroundings of the same frequency as the source current. This magnetic field induces eddy currents in its surrounding electrical conducting metal objects. The induced eddy currents have the same frequency but different direction to the source current. These induced currents produce Joule heating (I^2R) in the surrounding metal objects. The current distribution is never uniform hence the heat source is never uniform; hence the temperature profile is never uniform. Alternating current tends to run at the surface of the body; hence the heat source in induction heating is concentrated close to the surface. This is known as the skin effect [4].

Induction heating is entirely dependent upon the metallurgical properties of the metals on which it is being applied. Metals have electromagnetic properties in the same way as they have thermal and structural properties. The most important electromagnetic properties needed for simulating induction heating are the metal's electrical conductivity and magnetic permeability.

The electrical conductivity σ is the materials ability to conduct electrical current and its units are the reciprocal of ohm meter, (1/Ω-m), or mho per meter (mho/m) or Siemens per meter (S/m). The reciprocal of electrical conductivity σ is known as electrical resistivity ρ with unit's ohm meter (Ω-m). Good electrical conductors have high conductivity or low resistivity like copper. Electrical resistivity should never be confused with electrical resistance. The electrical resistivity of the material is an imperative physical property affecting induction heating by the depth of heating, uniformity of heating, coil electrical efficiency and coil impedance.

The relative magnetic permeability μr of the material indicates the ability of the material to conduct magnetic flux better than a vacuum and affects all induction phenomena. The permeability of free space is

$$\mu_o = 4\pi \times 10^{-7}$$

Henry per meter (H/m) or Weber per Ampere meter (Wb/(A.m)). The product of the magnetic permeability of free space μo and the relative magnetic permeability of the material μr is known as the magnetic permeability μ of the material.

$$\mu = \mu_r \mu_o \quad (1)$$

The magnetic permeability of a material corresponds to the ratio of the magnetic flux density $\vec{B}$ to the magnetic field intensity $\vec{H}$. The units of the magnetic flux density $\vec{B}$ are (Tesla) which corresponds to (Vs /m^2) or (Wb/ m^2) or (N/Am). The units of the magnetic field intensity $\vec{H}$ are (A/m).

Alternating current in a conductor has the maximum current concentrated in the conductor's surface as opposed to direct current that has the maximum current concentration at its center. The current distribution with alternating current is known as the skin effect. The skin effect occurs with the induced current in the surrounding metal objects being magnetized, with no current flow in the center of the object. Approximately 86% of the power is concentrated in the surface layer of the conductor. This surface layer is called the penetration or skin depth δ and can be derived from the Maxwell equations

Best Paper: Induction Heating Simulation Continued

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}} \qquad (2)$$

where f is the frequency in Hertz [Hz]. Typical frequency ranges for induction heating are 5 kHz to 100 kHz. From equation (2) it can be seen that the skin depth depends on the conductor properties and the frequency of the current in the conductor. When simulating the induction heating the skin depth given in equation (2) is a very important parameter when creating finite element meshes.

Electromagnetic field modeling

The electromagnetic phenomena of induction heating are described mathematically by the Maxwell equations. Maxwell's equations in differential form can be written as

$$\nabla \times (\vec{H}) = \vec{J} + \frac{\partial \vec{D}}{\partial t} \qquad \text{(from Ampere's law)} \qquad (3)$$

$$\nabla \times (\vec{E}) = -\frac{\partial \vec{B}}{\partial t} \qquad \text{(from Faraday's law)} \qquad (4)$$

$$\nabla \cdot (\vec{B}) = 0 \qquad \text{(from Gauss's law)} \qquad (5)$$

$$\nabla \cdot (\vec{D}) = \rho^{charge} \qquad \text{(from Gauss's law)} \qquad (6)$$

Where $\vec{H}$ is the magnetic field intensity, $\vec{J}$ is the conduction current density, $\vec{D}$ is the electric flux density, $\vec{E}$ the electric field, $\vec{B}$ the magnetic flux density and ρ^{charge} the electric charge density with *t* being time.

The above representation of the Maxwell equations has more unknowns than equations and these equations need to be reduced. $\vec{D}$ and $\vec{H}$ can be related to $\vec{E}$ and $\vec{B}$ through the electromagnetic material properties of permittivity ε and magnetic permeability μ by the following equations

$$\vec{D} = \varepsilon \vec{E} \qquad (7)$$

$$\vec{B} = \mu \vec{H} \qquad (8)$$

The Maxwell equations can be further reduced using Ohm's law.

$$\vec{J} = \sigma \vec{E} \qquad (9)$$

Rewriting equation (3) using equations (7) and (9) and noting that for current frequencies of less than 10 MHz the induced current density $\vec{J}$ is greater than the displaced current density $\frac{\partial \vec{D}}{\partial t}$,hence this term can be ignored. Equation (3) is then rewritten as

$$\nabla \times (\vec{H}) = \vec{J} \qquad (10)$$

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Since the magnetic flux density $\vec{B}$ satisfies zero divergence, equation (5), it can be expressed as a magnetic vector potential $\vec{A}$ such that

$$\vec{B} = \nabla \times \vec{A} \quad (11)$$

Substituting equation (11) into equation (4)

$$\nabla \times (\vec{E}) = -\nabla \times \frac{\partial \vec{A}}{\partial t} \quad (12)$$

Therefore

$$\vec{E} = -\frac{\partial \vec{A}}{\partial t} - \nabla \varphi \quad (13)$$

where φ is the electric scalar potential. Equation (9) now becomes

$$\vec{J} = -\sigma \frac{\partial \vec{A}}{\partial t} + \vec{J_s} \quad (14)$$

Where $\vec{J_s}$ is the amplitude of the source current density in the coil and is given by

$$\vec{J_s} = -\sigma \nabla \varphi \quad (15)$$

Substituting equations (8), (11) and (14) into (10) we get

$$\frac{1}{\mu}(\nabla \times \nabla \times \vec{A}) = \vec{J_s} - \sigma \frac{\partial \vec{A}}{\partial t} \quad (16)$$

Now using the triple product vector identity equation (17) on equation (16)

$$\vec{A} \times (\vec{B} \times \vec{C}) = (\vec{A} \cdot \vec{C})\vec{B} - (\vec{A} \cdot \vec{B})\vec{C} \quad (17)$$

Equation (16) becomes

$$\frac{1}{\mu}\left(-\nabla^2 \vec{A} + \nabla (\nabla \cdot \vec{A})\right) = \vec{J_s} - \sigma \frac{\partial \vec{A}}{\partial t} \quad (18)$$

Best Paper: Induction Heating Simulation Continued

Now noting that for one component vector potential fields

$$\nabla \cdot \vec{A} = 0 \quad (19)$$

Hence equation (18) reduces to

$$\frac{1}{\mu}(\nabla^2 \vec{A}) = -\vec{J_s} + \sigma \frac{\partial \vec{A}}{\partial t} \quad (20)$$

It is assumed that currents have a steady state quality. Therefore electromagnetic field quantities in Maxwell's equations are harmonically oscillating functions with a single frequency. For the sinusoidal steady state with angular frequency ω = 2πf with units (rad/s), equation (20) becomes

$$\frac{1}{\mu}(\nabla^2 \dot{A}) - i\omega\sigma\dot{A} = -\dot{J}_s \quad (21)$$

Once the time harmonic magnetic vector potential $\dot{A}$ is solved the magnetic field flux density can be found from equation (11). The time harmonic induced eddy currents $\dot{J}_e$ in the conductors is given by equation (22)

$$\dot{J}_e = -i\omega\sigma\dot{A} \quad (22)$$

From which the Joule heat $\dot{Q}$ in the conductors can be found by

$$\dot{Q} = \frac{1}{2\sigma}\left|\dot{J}_e\right|^2 \quad (23)$$

The Joule heat $\dot{Q}$ is the volumetric heat source with units (W/m^3) that is induced by the Eddy currents in the conductor.

The heat transfer phenomena taking place in induction heating is the heat conduction within the conductor and is described by the transient heat conduction equation that is used in all the simulations [5-6].

$$\rho C_p \frac{\partial T}{\partial t} = k\nabla^2 T + \dot{Q} \quad (24)$$

Where T is temperature, ρ the density, C_p the specific heat capacity, k the thermal conductivity of the material and $\dot{Q}$ the Joule heat from equation (23).

Best Paper: Induction Heating Simulation Continued

Finite element formulation

The finite element formulation has been used to solve equation (21) in order to get the heat source term equation (23) that will be used in the existing cool solver in solving equation (24). Since equation (21) is a time-harmonic simplified equation the magnetic vector potential $\vec{A}$ and the eddy currents $\vec{J}$ need to be expressed in complex number format.

$$\dot{A} = |A|e^{i\varphi_A} = \dot{A}_R + i\dot{A}_I \quad (25)$$

$$\dot{J}_s = |J_s|e^{i\varphi_J} = \dot{J}_{s_R} + i\dot{J}_{s_I} \quad (26)$$

Where $\dot{A}$ and $\dot{J}$ refer to a Cartesian component of the terms being solved and the R and I subscripts to the real and imaginary components of the complex number.

The Galerkin approximation is applied to equation (21) separately for each of the x, y and z components of the vector.

$$\int N^T \left(\gamma(\nabla \cdot \nabla)\dot{A} - \sigma i\dot{A} + \dot{J}_s\right)dv = 0 \quad (27)$$

resulting in 3 equations of the following form.

$$\left(\frac{1}{\mu}\int \nabla N^T \nabla N dv + i\sigma\omega \int N^T N dv\right)\{\dot{A}_R + i\dot{A}_I\} = \int N^T\{\dot{J}_{s_R} + i\dot{J}_{s_I}\}dv \quad (28)$$

Where N refers to the shape functions and υ to the volume of the element. Equation (28) is solved on each tetrahedral element for both the Real and Imaginary components of the unknown Cartesian components of the magnetic vector potential $\vec{A}$. Hence $\vec{A}$ has 6 degrees of freedom that need to be solved for.

The boundary conditions for solving Equation (22) are chosen such that the magnetic vector potential $\vec{A}$ is zero or its gradient is very small.

Simulation Technology

Induction heating is a complex technology, dependent upon the correct choice of mold materials, relying on the magnetic permeability and electrical resistivity of these materials. The strategic placement of highly magnetic inserts on the part where heating is desired is very important as well the placement of metal inserts with poor magnetic properties in the mold in order to enhance the magnetic field near the part is also required. The placement and exact geometry of the induction coils are very important and need to be modeled in exact detail. Many of these methods for enhancing the full potential of induction heating have been patented.

When simulating induction heating properly the user has to model the entire mold, custom specifying the electromagnetic material properties for all the mold components. The accuracy of the induction solution depends entirely upon the relative magnetic permeability and electrical resistivity in the mold and needs to be specified accurately. The thermal conductivity, density and specific heat also need to be specified by the user. Specific mold materials must be used for induction heating in order to get the full benefit of the technology. Ordinary mold materials are not highly magnetic thus will not be very efficient in induction heating applications.

Best Paper: Induction Heating Simulation Continued

The induction coils need to be modeled precisely in CAD and imported into the simulation environment. Once in the simulation environment the property of the CAD body needs to be set to Induction coil (3D). The high and low potential terminals on this coil body needs to be set as a boundary condition. On the high potential terminal the user needs to specify the source current being applied to the terminal or the voltage that is applied to it. The frequency of the alternating current applied to the coil needs to be set on the Induction coil (3D) property, on the body itself.

Induction heating relies solely on the skin effect see equation (2). As can be seen from equation (2) the skin effect depends upon the material properties in the mold and also the frequency of the alternating current in the mold. It is advisable for the user to calculate the skin effect thickness on all the bodies in the mold before meshing. It is recommended that the mesh size be set to at least the skin thickness size for the insert or body to be meshed. It is also recommended that enhancement layers be placed in the inserts such that the element height is at least a third of the skin thickness. If these rules are followed then the heat generated in the skin thickness should be captured entirely resulting in a very accurate solution.

With induction heating the current strength dictates the amount of power the mold will be heated by. From equation (2) it can be seen that the higher the frequency the thinner the skin depth. This means that with a higher frequency a thinner skin depth will be heated up faster and be hotter than the rest of the body. A lower frequency will ensure that a thicker skin depth region will be heated up slower and be cooler than if the frequency was higher. This phenomenon can be very useful in rapid heating and cooling applications if applied correctly at the design stage. Thin regions of the mold touching the part can be targeted for heating resulting in the bulk of the mold remaining very cold throughout the injection molding cycle negating the cooling stage of the process.

Induction heating relies on the geometry of the entire mold and on strategically placed inserts in the mold of different magnetic properties. Usually induction heating molds have a nickel based insert touching the part in order to enhance the skin effect. If the molds geometry and choice of materials can be a done precisely induction heating of molds can be very efficient.

Once the coils have been defined, boundary conditions and frequency set, with the mold meshed to the correct mesh size, the analysis can be started. The solver solves the Maxwell equations at the start of the Cool analysis and calculates the Joule heating and stores it in memory. After the solution of the Maxwell equations the ordinary three dimensional transient cool solution is performed as detailed in reference [5]. When the heaters are turned on in the simulation, the Joule heat calculated before is applied as the source term in equation (24). When the heaters are turned off the source term is ignored in the analysis.

All the standard results from the transient cool analysis are provided [6]. However, when induction heating coil elements are present in the model an induction heating analysis will take place. Induction heating specific results are then provided as well. The Joule heat $\dot{Q}$, magnetic vector potential $\vec{A}$, induced and source current densities $\vec{J}$, and the magnetic flux density $\vec{B}$ are new results specific to induction heating.

Due to the skin effect the induction heating simulations are very sensitive to the mesh size. The frequency chosen and the mesh size are mutually dependent. If the frequency is too high for the mesh size then the system of equations from equation (28) are no longer diagonally dominant resulting in an ill-conditioned matrix. The ill-conditioned matrix does not solve easily and may take a very long time to solve, if at all. Special matrix solvers are applied to this problem.

Validation and Verification

There is very little published data on induction heating applications for injection molding that can be used for validation and verification. Data that can be found comes from academic institutions and are not very relevant to real world injection molding cases. These cases are not practical and are mostly two dimensional in nature.

After doing an exhaustive literature survey looking for validation data the following salient points regarding induction heating in plastic injection molding can be made. Commercially there seem to have only been two companies that specialized in induction heating for plastic injection molding. Through acquisition these entities have become one, owning several patents in the induction heating field.

There is a lot of intellectual property and "know how" involved in designing a mold for induction heating. Induction heating relies on the magnetic and electrical properties of the mold and the placement of strategic inserts and air gaps is very important in the mold design. A mold designer designing a mold for induction heating will need to have substantial electromagnetic knowledge, skills and experience to extract the benefits from induction heating.

Results and Discussion

In order to demonstrate the simulation of induction heating the part, mold, induction coil and insert combination shown in **figure 1** is used to demonstrate induction heating. A circular part is located on a circular nickel insert and just above the nickel insert is the induction coil. This combination is placed in a non-magnetic steel mold.

By looking at **figure 1** the high and low potential boundary nodes are visible. For this particular case an alternating current of 200 ampere is cycled at a frequency of 10 kHz in the induction coil. The induction coil shown in **figure 1** is made of pure copper and has an electrical resistivity of 1.666 10^{-8} (Ω-m). The relative magnetic permeability of the Copper coil is 1.0. The thermal conductivity of the copper is 400 (W/mK), the density 8700 (kg/m^3) and the specific heat of 385 (J/kgK). The mold is made from non-magnetic tool steel with an electrical resistivity of 6.99 10^{-7} (Ω-m) and a relative magnetic permeability of 1.0. The thermal conductivity of the steel is 28(W/mK), the density 7750 (kg/m^3) and the specific heat of 460 (J/kgK). The insert butting up against the part is made from nickel with an electrical resistivity of 6.99 10^{-8} (Ω-m) and a relative magnetic permeability of 100. The thermal conductivity of the nickel is 91(W/mK), the density 8900 (kg/m^3) and the specific heat of 460 (J/kgK).

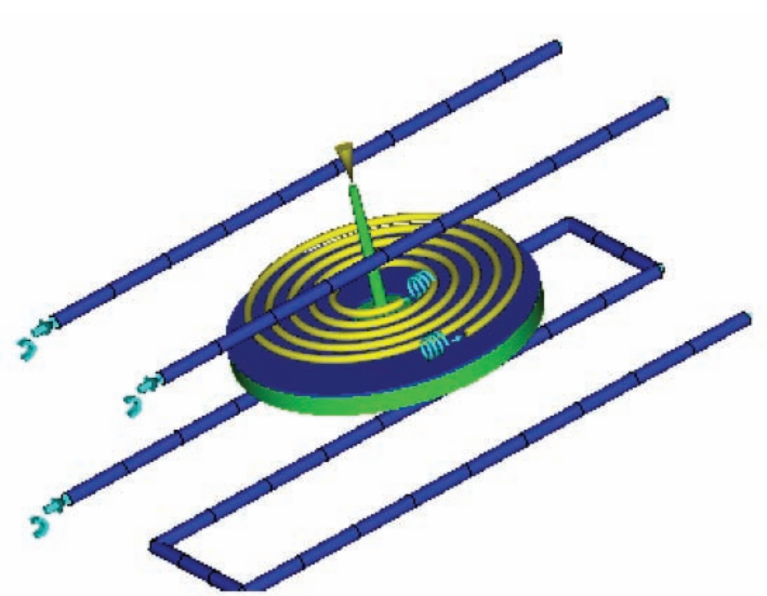

Figure 1: Induction heating part, insert and coil.

The mold has cooling circuits that are used to cool the mold down after the part has been filled with hot molten polymer. The process has a combined injection, packing and cooling time of 30 seconds, after which the mold

Best Paper: Induction Heating Simulation Continued

opens, the part is ejected and the induction heating begins. During induction heating alternating current is cycled through the induction coil. The induction heating is turned on for 5 seconds after which injection of the next cycle begins. During this phase the surface temperature of the insert in contact with the part is heated up.

Figure 2 is a result plot on a cutting plane showing the distribution of the alternating source current density in the induction coil brought about by the 200 amp input current that is cycled through the coil at 10 kHz. This plot is a vector plot showing the direction of the source current with the length and color of the vector indicating its magnitude.

The alternating source current shown in **figure 2** in the coil gives rise to an alternating magnetic field around the coil. **Figure 3** shows the magnetic flux density, equation (11), result in the mold and the nickel insert. Once again this result is a vector plot.

This magnetic field, **figure 3**, in turn gives rise to an induced electric current in the coil surroundings. **Figure 4** shows the induced electric current, equation (22), result provided by the solver. This result is also a vector result with the arrows indicating the direction of the induced current.

The induced electric current gives rise to joule heating within the mold and the insert. Joule heating is given by equation (23). By carefully selecting the materials in the mold the induced current can be used to generate heat in targeted areas. **Figure 5** shows joule heat being generated on the surface of the nickel insert.

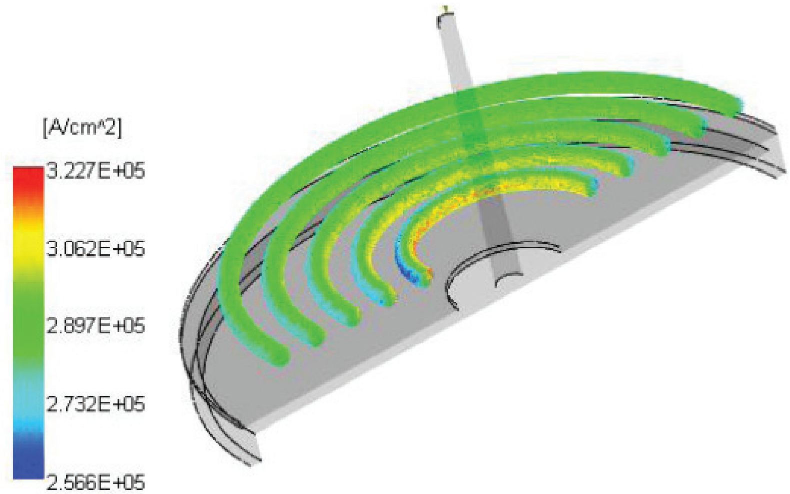

Figure 2: Alternating source current density in the coil.

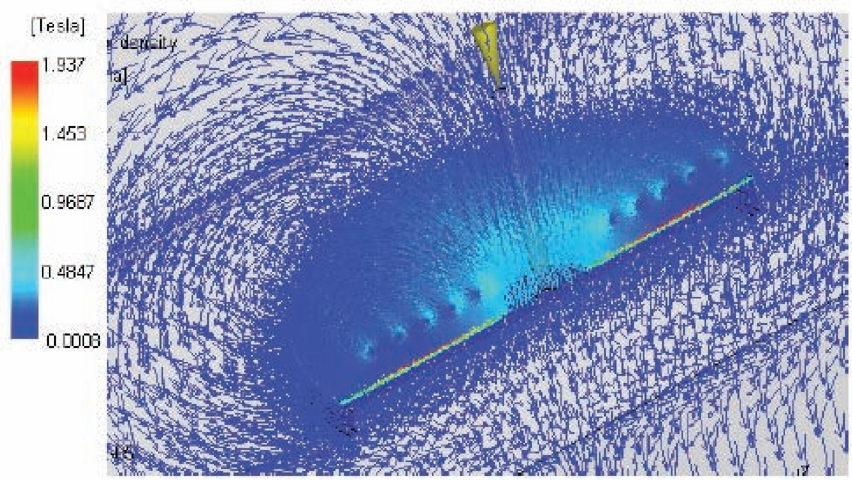

Figure 3: Magnetic flux density results in the mold.

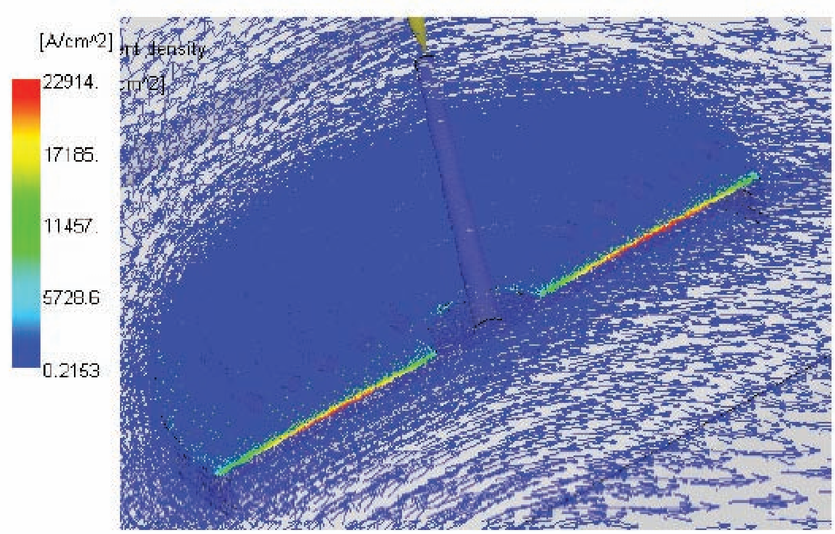

Figure 4: Induced current density result in the mold.

Best Paper: Induction Heating Simulation Continued

Since the insert is made from nickel it has more favorable material properties for generating heat than the ordinary tool steel used in the mold. **Figure 6** shows the joule heat generated in the mold, nickel insert combination on a cutting plane. From **figure 6** it can be seen that more heat is generated in the nickel insert, especially in the skin depth of the nickel insert than in the metal mold itself.

Figure 7 shows the temperature through a cross section of the mold at 30 seconds into the cycle time. This corresponds to the moment when the part is ejected from the mold and the induction heater is turned on in preparation for the next cycle. As can be seen from **figure 7** the maximum temperature in the mold at 30 seconds is 25.70 ºC.

Figure 8 shows the same cross section through the mold but at the time of 35 seconds. This corresponds to the time when the induction heater is switched off. This is also the end of the clamp open time and also the start of the next cycle. As can be seen from **figure 8** the maximum temperature in the mold is 87.16 ºC. This means that the maximum temperature in the mold has risen from 25.70 ºC to 87.16 ºC during the 5 seconds of induction heating in this model. This temperature gain is significant.

An intermediate result is the magnetic vector potential is which given by equation (21). Equation (21) is the principle differential equation solved for electromagnetic induction heating. The magnetic flux density, induced current and ultimately the joule heat are derived from the solution of this equation. **Figure 9** is a plot of the magnetic vector potential in the mold, mold insert combination.

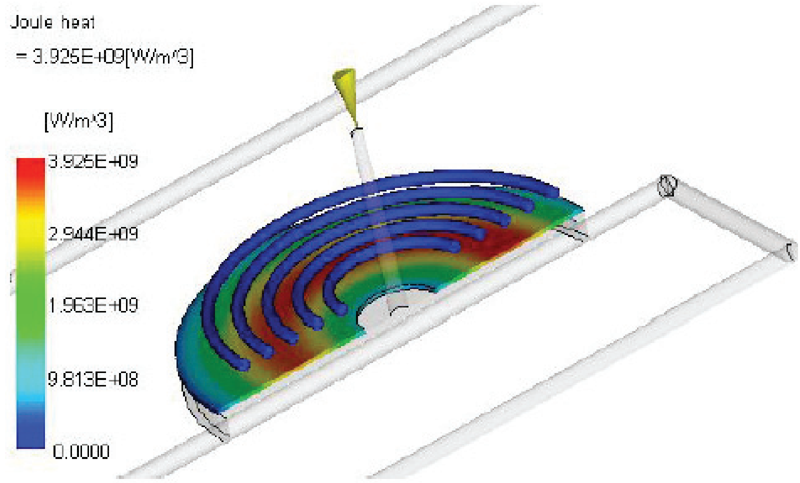

Figure 5: Joule heat generated on insert surface.

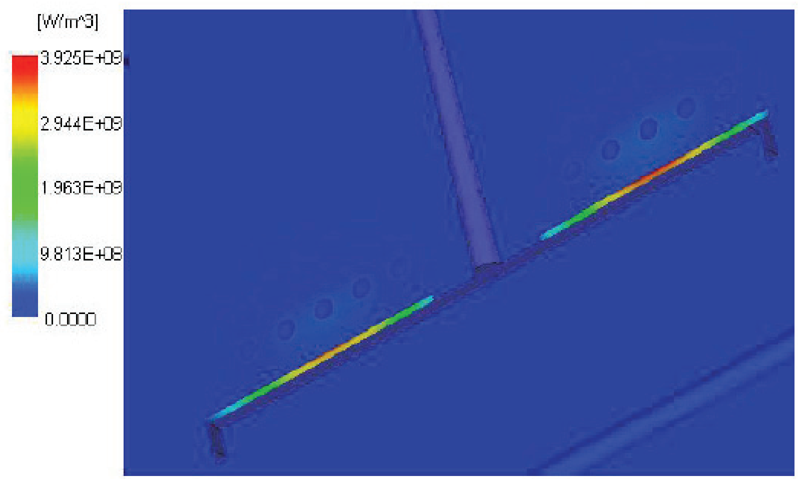

Figure 6: Joule heat generated in the mold and insert.

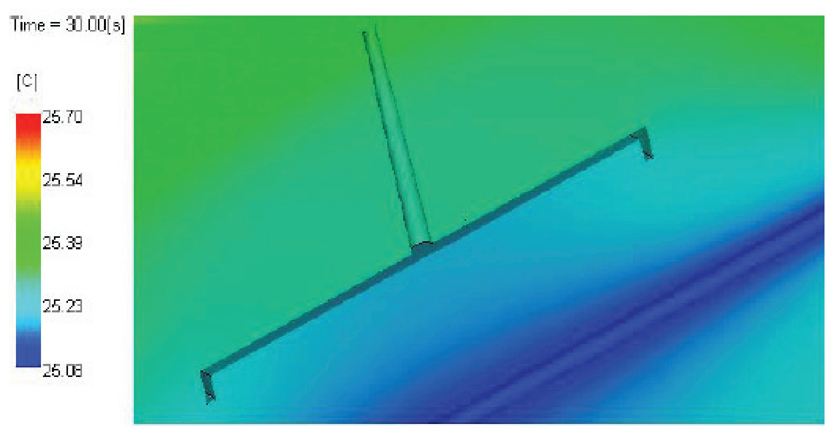

Figure 7: Temperature in mold at Time=30 seconds.

Best Paper: Induction Heating Simulation Continued

Conclusions

The induction heating feature provides worthwhile functionality to the existing transient cool solver. Induction heating adds extra functionality to the rapid heating and cooling modules.

The numerical results predicted from the solution of the Maxwell equations agree with results published by academic institutions.

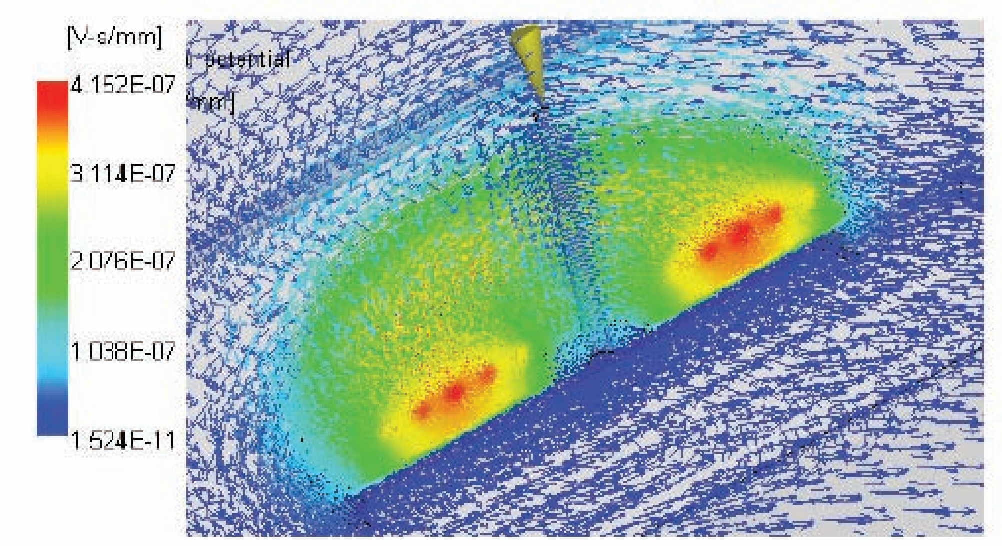

Figure 9: Magnetic vector potential in mold.

At present the physical induction heating process in injection molding seems to be protected by patents and the authors are collaborating with a provider in order to validate this solver with actual experimental data.

The induction heating module can be used with confidence by users who are considering using commercial induction heating. The module can also be used by current users who want to gain a better understanding of the actual processes.

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Key Words: Injection molding, Autodesk, transient cool, simulation, rapid heating and cooling, variotherm, induction heating, Maxwell equations, skin depth. Penetration depth, magnetism.

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FARPLAS Using Moldex3D to Overcome Difficult Molding Issues in Multi-shot Injection Molding

FARPLAS is a world leading auto manufacturer that operates as a full-system supplier and determines to sustain the best outcomes at the lowest costs. With more than 40 years of experience, the spirit of an investor, global understanding, and customer oriented approach, it has excelled in every field it operates. (Source:http://www.farplas.com.tr)

Executive Summary

This study examines the filling analyses of PP+GF30 and ethylene propylene diene monomer (EPDM), consecutively. It is particularly difficult to work with this multi-shot injection molding. Glass fiber must be oriented along the flow direction, influencing the part deformation. If the distorted piece cannot be fitted accurately while being inserted to the other compartment, EPDM filling cannot be performed. Another problem is the inability to fill a fine-layered EPDM onto PP+GF30 in a full balanced manner. Several analyses on a gasoline tank casing mold have been performed in Moldex3D. The results help to foresee the potential issues and save time for proper modifications, accordingly.

Challenges

- Undesirable deformation after PP+GF30 filling
- Correct gate locations and cross-section of the passage for EPDM filling
- Sufficient EPDM filling amount to compensate the quantity and the interval of the hot runner as well

Solutions

Moldex3D can help to obtain correct design modifications, which result in smaller warpage in the first filling (PP+GF30) and good filling behavior without short shot in the second filling (EPDM); its high mesh level option also leads to closer results (nearly 100% accurate) between simulation and experiment.

Sponsor Case Study: Moldex3D

Benefits

Product Quality Improvement:

- Reduce total displacement of PP+GF30 filling
- Achieve short-shot-free EPDM filling
- Obtain close-to-100% accuracy between simulation and experimental results of warpage and filling behavior
- Save the required time to finish the design modifications as well as production cycle time and development costs

Case Study

The objective is to solve the problems in multi-shot injection molding of PP+GF30 and EPDM in which the warpage resulted from the first filling (PP+GF30) should be minimized to a certain level to avoid any mismatch when the part is inserted to the other compartment for the second filling, and the cavity of the second filling (EPDM) should be properly designed to ensure a complete filling.

In this case, Moldex3D was first utilized before commencing the mold design of the first filling in order to initially obtain the right design with acceptable part deformation. Then, the analysis of the second filling was carried out, while the first mold design was underway. Finally, the mold design of the second filling referred to the modified one after the short-shot problem had been overcome through the simulation analysis. Moldex3D detected the two critical issues for this case: warpage problems from the first filling and incomplete filling from the second filling. The design modifications for the cavity of the first filling comprised the addition of ribs at certain regions to support part rigidity and the removal of some particular regions to promote more uniform wall thickness. (**Figure 1**) As the supporting ribs were added, the warpage from the first filling was reduced. (**Figure 2**)

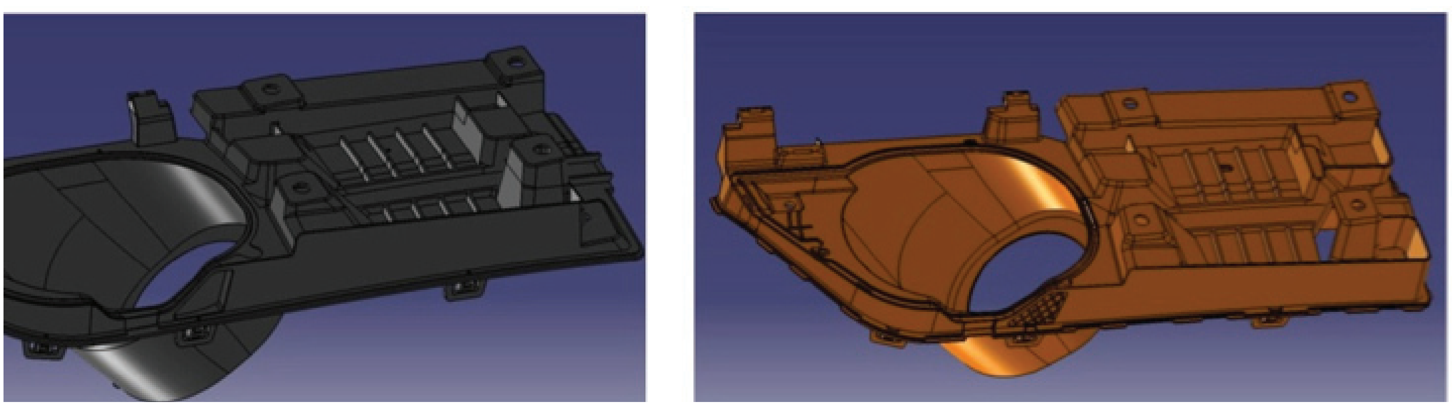

Figure 1: Compared to the original design for the cavity of the first filling (left), the final design (right) has more ribs, and some of its sections have been core out.

Sponsor Case Study: Moldex3D

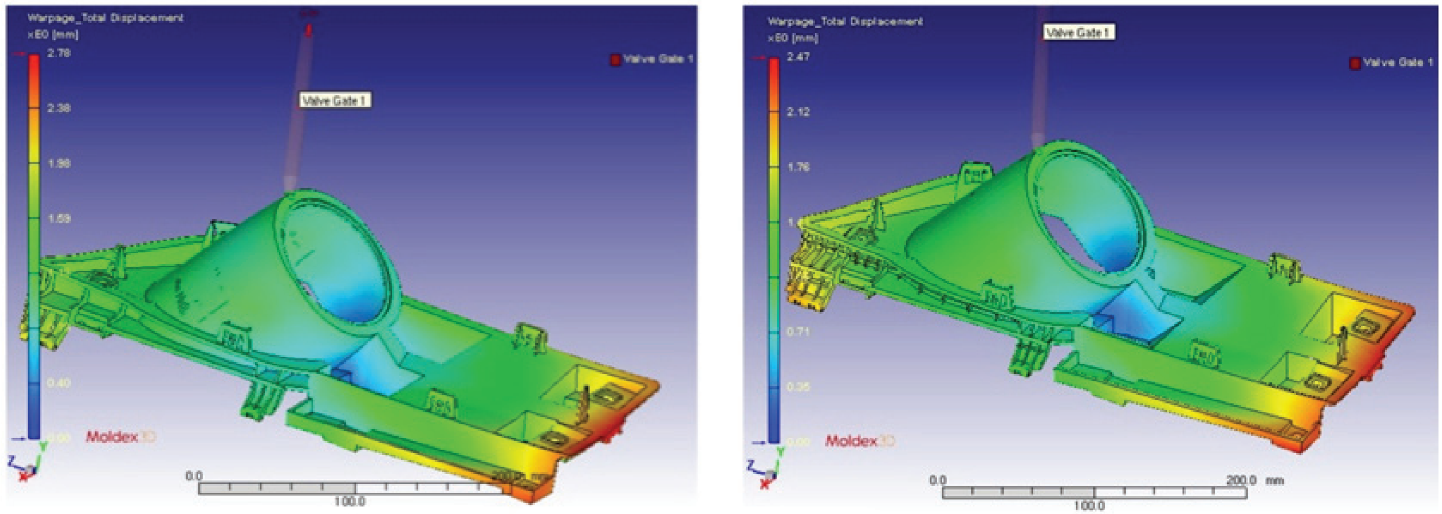

Figure 2: The original design without supporting ribs (left) results in larger warpage total displacement (max: 2.78 mm) than the modified design with supporting ribs (right) (max: 2.47 mm).

The design modifications for the cavity of the second filling comprised the geometry **(Figure 3)** and the thickness (**Figure 4**). Due to these changes, the EPDM filling behavior had been improved so that the filling could be completed without any short shot. (**Figure 5**)

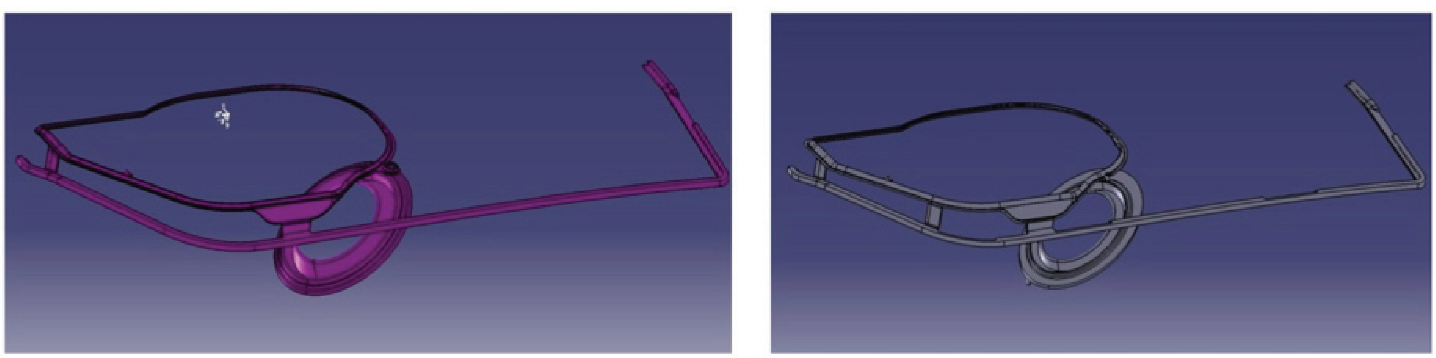

Figure 3: The geometry of the original design for the cavity of the second filling (left) has been modified for its final design (right).

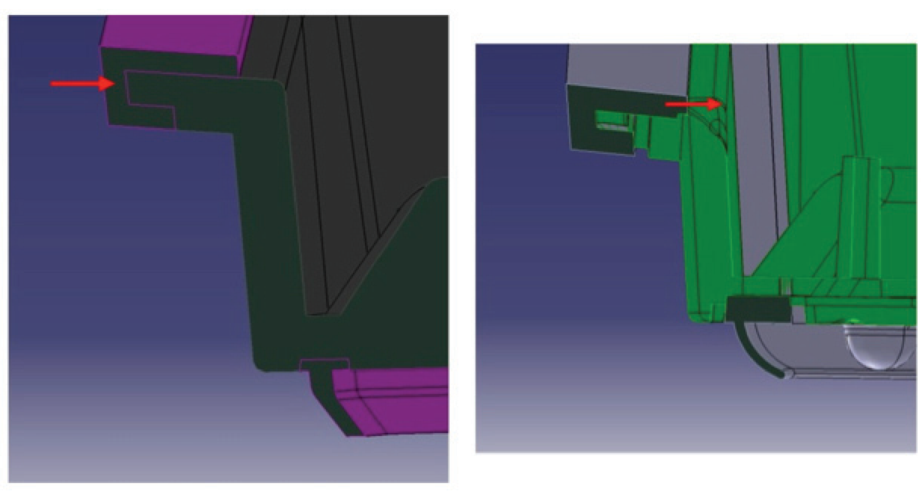

Figure 4: The thickness of the EPDM passage in the final design (right) have been increased, compared to the original design (left).

Sponsor Case Study: Moldex3D

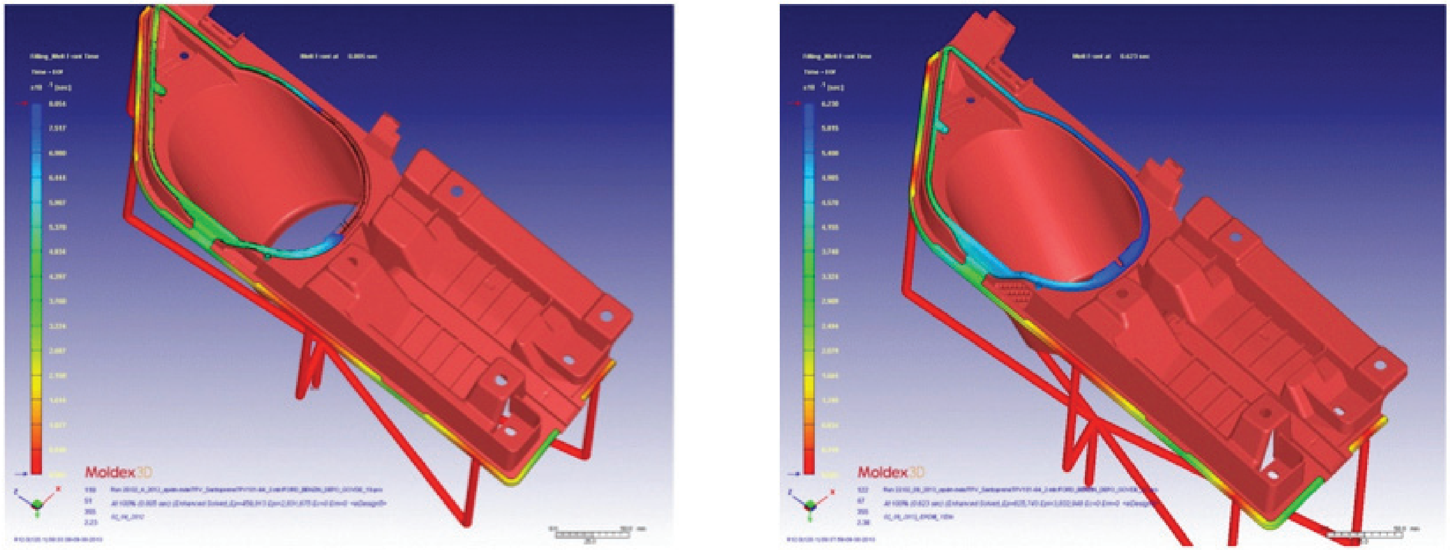

Figure 5: The short shot problem for the original design (left) has been solved in the final design (right).

The design revisions were verified by comparing their filling results with the results from their original designs in which the improvements could be observed; the warpage had been minimized and the short s hot had been solved. Furthermore, the simulation results were also compared to the experimental results in which both simulation and experiment were in a good agreement; the similarity was nearly 100% accurate when the mesh level for the simulation analysis was changed from 3 to 5. One of the examples is the following short shot issue from EPDM filling (**Figure 6 & Figure 7**):

Figure 6: The short shot location of the original design in the simulation (left) is similar to the one in the experiment (right).

Sponsor Case Study: Moldex3D

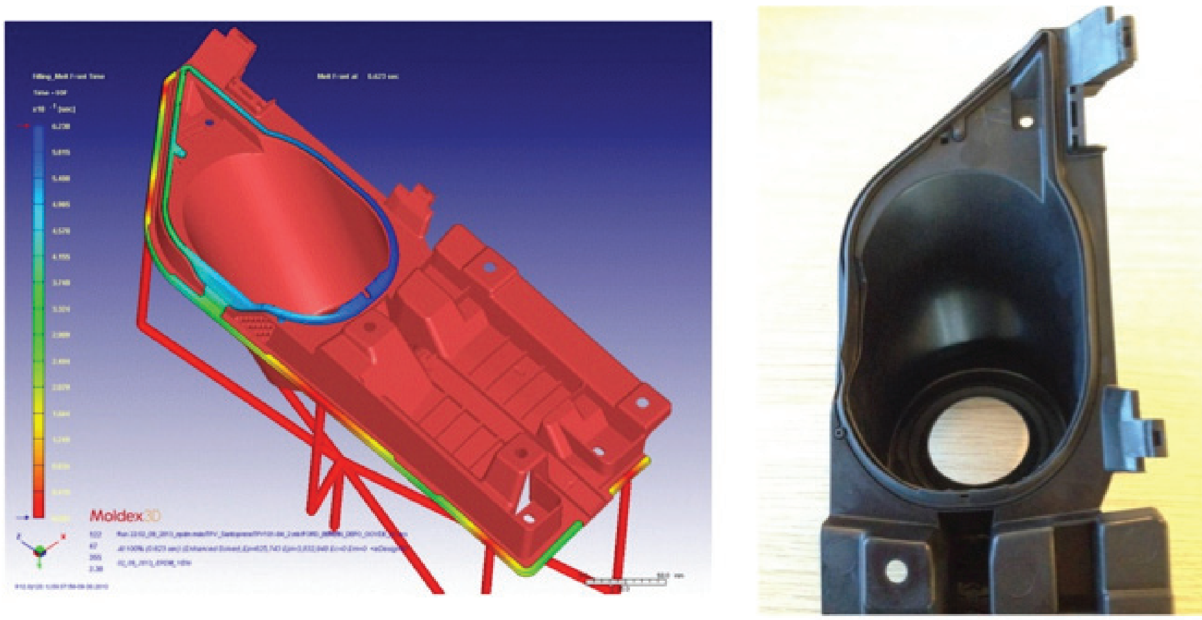

Figure 7: Both simulation (left) and experiment (right) result in short-short-free filling in the final design.

Results

Through Moldex3D analyses, both warpage of the first filling (PP+GF30) and filling behavior of the second filling (EPDM) could be understood well. By providing the mesh level of 5 for the simulation model, the simulation results could be nearly 100% accurate compared to the experimental results. These benefits could help to predict the potential manufacturing difficulties prior to the actual production, so any necessary modifications could be made beforehand, which in turn had savedalot of time for design improvements and development. As a result, FARPLAS A.S. could successfully solve the critical manufacturing issues in this multi-shot injection molding.

For more information contact:
Likai Li, PhD at likai.lee@gmail.com
CELAL SELİM YILDIRIM, Senior Mold Designer at s.yildirim@farplas.com

SPE IMD Councilor Report

February 5, 2016

Remote Meeting (Conference Call)

Submitted by Susan Montgomery, IMD Councilor

SPE President Dick Cameron welcomed all councilors. Approval of the October 2015 Council meeting minutes will be done during the Council meeting in May.

Financial Update: Wim DeVos, SPE CEO (Chief Staff Officer)

- Year end 2015 closing report is in progress. Should be completed by end of March.
- Wim expects that 2015 will be a break-even year (ie. approx -7K USD).
- Cash has been well managed. Revenue streams came from: membership, advertisement/ sponsorships, events (2015 was NPE year), publications. Expenses for membership and governance were reduced by 25% and 20%, respectively. Operational expenses were up slightly due to staff salaries and new products. Wim's report is posted on The Chain.

Governance Task Force Update (GTF): Scott Owens

Task Force Members: Scott Owens, Paul Browitt, Cor Janssen, Sandra McClelland, Sergio Sanchez, Scott Steele, Dick Cameron

The members of the Governing Body (GB) will be elected by either Council or SPE membership. Roles and qualifications for each position will be defined by a job description. These positions are elections, not appointments. There will be two-year terms with lifetime limits (four time succession, or 8 year maximum). The expectation is that GB members will commit to approximately 25 hours of service per month.

In thinking forward, an emphasis on leadership development (to develop a leadership pipeline) will be introduced. This will involve a structured platform to identify and develop future leaders.

Updates from the GTF are published on The Chain.
Specific actions to move forward will be presented in May at the ANTEC Indianapolis Council meetings.

Virtual Elections: Wim DeVos

Schedule for upcoming e-vote officer elections by Council listed below. 50% Council majority must vote.
Candidates nominated and endorsed by SPE Nomination Committee:
President Elect: Raed Al-Zubi
Senior VP: Thierry D'Allard

IMD Councilor Report Continued

VP: Rodney Lee Joslin; Rochelle Lemieux; Rajiv Sanghavi; Sassan Tarahomi
Submitted candidacy for President Elect: Greg Campbell

Per the bylaws:

- *For electronic voting, nominations at large must be received by the Nominating Committee Chair not less than 15 days before the voting will begin.*
- *Therefore, any nominations from the floor must be received by Vijay Boolani vboolani@4spe.org no later than **March 20, 2016**.*

Once the polls open Councilors will receive ballots via email and will have 24 hours to cast the votes. If there is not a clear winner in each category there will be a revote for that position. The process timeline will be as follows:

Voting Begins for President-elect	**Monday, April 04, 2016**
Voting Begins for Senior VP	**Monday, April 11, 2016**
Voting Begins for VP	**Monday, April 18, 2016**

ANTEC SPE Reception, Monday evening, May 23, 2016

Solely supported by funds from Divisions and SIGs. Each supporter will have a certain number of drink tickets available, and will be provided with a tabletop. Scott Marko from SPE Headquarters is in charge of this event. Susan Montgomery will coordinate IMD participation with Scott.

By-Laws Committee (Bruce Mulholland)

The following were voted upon and passed by Council:

Article 4.5.2: e-member vs full member expulsion review process

Policy 011: Regarding dues for unemployed members

Policy 013: Section establishment, including rebates and expenses

Policy 014: Division establishment (change of language to accommodate changing IRS requirements; bank account establishment for divisions not permitted to set up bank accounts

Next Council Meeting: ANTEC, Indianapolis, IN: May 21 and 22, 2016

COMMENTS, QUESTIONS, CONCERNS ARE ENCOURAGED. PLEASE SEND TO:
Susan Montgomery, IMD Councilor
SUSAN MONTGOMERY, IMD COUNCILOR
susan.elizabeth.m.montgomery2@gmail.com

IMD Board of Directors Meeting

January 22, 2016

Orlando, FL

Submitted by Srikanth Pilla

Welcome

Chair David Okonski called the meeting to order at 9:00 AM ET. He welcomed all attendees to the meeting, and thanked Tupperware for hosting the reception and the Board meeting.

Before the roll call David O gave an 'awakening' presentation on how to expand Board's capabilities to gain more revenue. IMD is the largest division in terms of member base but not so much on revenue. We only focus on ANTEC but not so on other activities and we need to change that to reach to wider community and increase our revenue so that we can do more giving towards educational activities within SPE.

Roll Call

Present were: David Okonski (Chair), David Kusuma, Hoa Pham, Jim Wenskus, Peter Grelle, Jeremy Dworshak, Raymond McKee, Tom Turng, Susan Montgomery, and Srikanth Pilla

Teleconference: Mike Uhrain, Rick Puglielli, Erik Foltz, Jack Dispenza, Brad Johnson, Larry Schmidt, Jon Ratzlaff, Adam Kramschuster, Kishor Mehta

Absent were: Nick Fountas, Vikram Bhargava, Lee Filbert, and Mal Murthy

This constituted quorum.

Keynote Presentation – Bill Wright

Bill Wright, EVP Supply Chain of Tupperware, gave a keynote presentation on the Importance of Innovation in Plastics

Approval of October 4, 2015 Meeting Minutes
Motion: Srikanth moved that the October 4, 2015 meeting minutes be approved, as written and distributed. Motion passed.

Financial Report – Jim Wenskus, Treasurer

- Jim presented the financials from June 30, 2015 to Dec 31, 2015 Balance sheets were shared.
- There was discussion to increase the contribution towards educational activities to cover the outreach that board members are doing with various Universities.
- The budget for fiscal year June 30, 2016 to July 31, 2017 was also presented.

IMD Board of Directors Meeting Continued

Councilor Report – Susan Montgomery

- Susan provided an update on the governance meeting held in Pittsburgh, Oct 9-11, 2015 wherein it was discussed to better reform the governance structure based on other non-profit organizations
- Remote council meeting is on 5th Feb, 2016 wherein for the first time the council will meet remotely and vote on bylaws, governance, etc.
- The proposed governing body positions and terms are:
    - President, 1yr, progression
    - President-elect, 1yr, elected by council
    - Past president, 1yr, progression
    - VP Sections, 2yr, elected by council
    - VP Divisions, 2yr, elected by council
    - VP Young Professional, 2yr, elected by council
    - VP Finance and Business, 2yr, elected by council
    - VP Events, 2yr, elected by council
    - VP Marketing, 2yr, elected by council
    - VP Education, 2yr, elected by council
    - Chief Staff Executive

The nomination procedure for any of the above positions is not yet defined.

- Jon Ratzlaff (Past SPE President and current IMD board member) agreed to mentor any interested board members for the above positions.
- Susan discussed with other councilors to do a minitec and there was a response from North Texas for a joint minitec in April. More discussion and notes in Outreach.

ANTEC 2016 Report – Jeremy Dworshak, TPC, ANTEC 2016

- IMD has 8 sessions for ANTEC 2016.
- Overall the software is pleasing but there is no means to send the comments directly to authors via submission. Instead the TPC has to email personally.
- Having someone from academia is a big boost to the committee since they have the literature background and knowledge that is good for the review process.
- Srikanth put forth a proposal to expand the review committee by including all the board members but instead of everyone reviewing all the papers, the TPC will ensure to send each paper to 3 reviewers. This will lower the burden on TPC committee to review 55+ papers. However, the committee will still meet in person to discuss the scores and comments.
- The IMD reception will be held on Tuesday, 24th May 2016 at 5:30 pm
- David O presented the idea (currently implemented) to decouple sponsorship money from reception so that the sponsors get higher ROI for their sponsorship. Ideas were solicited for a new sponsorship model for 2017 which includes a new high level i.e. Platinum. Please provide your feedback on how else we can give higher value to sponsors to David Okonski (david.a.okonski@gm.com).
- Heidi has designed two fliers to reach out potential sponsors. All board members are requested to vote on it and send your comments to David O.

IMD Board of Directors Meeting Continued

- Also, so far we have a total sponsorship of $15000 for 2016 but more is being solicited. Please reach out to your known contacts to solicit sponsorship.
- David O has put a sponsorship committee during his tenure as chair. Since he is stepping down, the committee disappears. However, since all felt there is a value for this committee, according to the bylaws, David O will put together a working document for the roles and responsibilities which will be reviewed at the next board meeting.

Ray Mckee will be taking over the chairmanship at ANTEC 2016 and he proposed to hold the next board meeting the Sunday before ANTEC. Ray will follow-up on this with the board.

Technical Director's Report – Pete Grelle

- Pete congratulated Jeremy for doing an excellent job as TPC.
- Pete presented the technical report for the papers from 1992-present categorized into sources, types geographic and quality.
- There will be an IMD Topcon to be hosted by Penn State Erie from June 22-23 2016. If you want to present, please contact Brad Johnson.
- Also, there is an interest from North Texas division for a minitec in April (pending SPE approval).
- The IMD webinar schedule for this year was presented with new topics:
    - New Process Technologies
    - Material Selection for Injection Molding
    - Troubleshooting the IM Process
- A historical perspective of IMD topcons were presented. The floor was open for discussion on what the future could be for organizing topcons either individually or jointly. Please send proposals to Pete Grelle.

Communications – Adam Kramschuster/Rick Puglielli

- Adam presented some updates on the website such as sponsor's banners being displayed on home page. If there are more changes that the board members see, then please email them to Adam Kramschuster.
- There was a discussion on how to direct traffic to our website such as putting our newsletter link only on our website and forcing all the hyperlinks point to it including the link in the mail list we send.
- Srikanth has requested to create a distribution list for BOD members so that whenever a member has a new contact info then he/she sends an update to webmaster and all the members still use the same email address to distribute content to the board. Adam will take this to the webmaster and inquire if creating such a distribution list is possible or not.
- Content for the Spring newsletter is due by Feb 10. Please send the content to Rick Puglielli and Heidi.

Membership Update – Nick Fountas

- Nick presented the membership statistics. We have 2,829 members with 286 new members in CY2015 and 1,045 lapsed members.
- Erik asked for distribution of North American members so as to understand where we need to focus our efforts in increasing the memberships.
- Nick presented a flier to distribute to encourage plastics community to join Injection Molding Division.

IMD Board of Directors Meeting Continued

Nick proposed to print maybe 500 copies of these to hand them over at ANTEC, TOPCONS, etc. Jeremy proposed a web link and make it less text and more graphic. Erik suggested to have a link (QR code) on a smart phone which directs to the website where they can apply for membership. Have some bullet points of benefits such as technical session, scholarship, etc. Any more changes, please send to Nick Fountas.

Nominations Committee Update – Hoa Pham

- Hoa presented new board officers: Jeremy Dworshak (Chair-elect), Jim Wenskus (Treasurer), Pete Grelle (Technical Director) and David Okonski (Secretary). Hoa moved the motion, Jeremy seconded it and the motion is passed.
- Nick Fountas, Kishor Mehta, Tom Turng, Adam Kramschuster, David Kusuma, Rick Puglielli, and Srikanth Pilla's board memberships were up for voting. Hoa moved motion, Jack Dispenza seconded and the motion passed for putting the members up for voting. Please send a short bio by 31st Jan to Hoa Pham so that she can put the members for voting across the SPE community.
- Hoa presented next year's (2017) board officers. Srikanth Pilla to be the TPC for ANTEC 2017.

HSM, Fellow Awards – Tom Turng

- Last year, IMD nominated two fellows. The SPE president will contact the selected candidates.
- Tom requested the board to provide nominations for Fellow and HSM.
- Vikram proposed to nominate Suhas Kulkarni for the SPE Fellow. Tom will follow-up on that.
- Tom will contact Rick Puglielli to solicit nominations for fellow and HSM from the IMD public.

Engineer of the Year Award – Kishor Mehta

- Adam Kramschuster was selected to receive the 2016 Engineer of the Year award.

IMD Outreach – David Okonski

- David presented opportunities for IMD to do minitec/protec/Topcon and create our own conference brand with focused markets or topics for these topcons.
- David also presented ideas to get sponsored IMD based products such as flash drives.
- David also presented SPE-Detroit's proposal to hire event manager who will do the promotional work on behalf of the section. If approved, this will immensely help SPE-Detroit's partnering divisions such as IMD, especially in revenue sharing.
- David presented Detroit section's AutoEPCON to be held on May 10, 2016 and requested board members and TPC committee to select 4-5 papers which focus on simulation, failure analysis, etc. The revenue sharing with IMD will not be in equal ratio but a proportion of it.
- SPE Detroit is also organizing SPE Automotive TPO conference in Oct 2-5 2016 in Shanghai, China. Tom and David Kusuma are helping through technical papers submissions and identifying keynote speakers.
- In general, it was decided to partner with other divisions and sections and co-organize their events. This will help to reach out to organize more technical sessions but also could a venue for more revenue generation.

IMD Board of Directors Meeting Continued

IMD Board Structure – David Okonski

- Committee structure: David O has shown the current chairs and co-chairs for all the IMD division committees.

COMMITTEE NAME	CHAIR	CO-CHAIR
Communications	Rick Pugilielli	Adam Kramschuster
Education	Srikanth Pilla	Jeremy Dwarshok
Membership	Nick Fountas	Erik Foltz
Engineer-of-the-year	Kishor Mehta	Jack Dispenza
Sponsorship	David Okonski	David Kusuma
ANTEC Reception	Srikanth Pilla	David Okonski
HSM and Fellows	Lih-Sheng Turng	Kishor Mehta
Nominations	Hoa Pham	Brad Johnson
Pinnacle Award	Raymond Mckee	David Okonski

- The idea is to have a backup board person assigned for every functional committee. If anyone has additional comments on the list, please let David O know.
- David O showed an org chart of the BOD structure. Requests that we review our bylaws and update our structure chart.
- Pete asked if everyone knows we have bylaws and if everyone has seen them. Everyone seemed to know there were bylaws but not everyone has seen them. Co-chairs would need to be added to the by-laws.
- Jon suggested we need to have by-laws but we need to focus on simplicity.
- David O mentioned that the chair has the authority to appoint committee chairs.
- Jon said the by-laws should have something to prevent people staying in committees too long. And the committees should promote succession.
- David O asked if we should solicit Kishor again to help review the by-laws.
- Pete asked if we should have a regular meeting (for example, at ANTEC) to review the by-laws regularly and keep it fresh.
- David O wants to email everyone the by-laws and we can vote during ANTEC to form a committee.
- Hoa said she felt maybe only an amendment to the by-laws is needed, not a re-write. David O agreed.
- David O will come to ANTEC with the first proposal to add a sponsorship committee and we can ask for volunteers and go from there.

IMD Board of Directors Meeting Continued

New Business/Other Topics – All

- **IMD Work Plan** - Ray brought up that he's concerned about our work plan, that we are failing to increase our membership by 5% each year. We had 3150 members last year, down to 2829 this year. We have lost about 10% of our membership. Ray wants everyone to know that we will not submit the same work plan when he takes over the chair. We are the largest division but we are shrinking. Nick mentioned he cannot look at the membership of other divisions because SPE national shut off that feature a few years ago. Nick proposed, and Ray and David O agreed that we should meet more often, maybe every month by teleconference. Erik mentioned that maybe not everyone needs to meet. David O will take the lead on developing the partnership for conference opportunities. Also with universities. Adam mentioned he will also be willing to host activities on his campus. Recycle TopCon for presentation at universities? Ray and David O proposed the following action items:
    - Decoupling sponsorship from receptions
    - Broadening education appeal
    - Ray wants to talk with David O once per week to get ready for his chairmanship.
    - Ray wants more actionable details for our work plan
- **Jim's Program in Rochester** - Jim Wenskus talked about educational events during the year (3-4 per year), has a vertical injection molding machine. The screw driver blades cost $0.75 from mail order. Looking for sponsorship.
    - Pete suggested to make a motion to support Jim's initiatives with $2000 per year from IMD. Motion was made and motion passed.
- **Additive Manufacturing Marketing Opportunities** – Jack Dispensa introduced this technology. Opportunity for SPE to get new members. Students are interested in this technology. AM processes are moving fast, for all market segments.
    - Wants everyone to inform about the AM SIG and ANTEC sessions.
    - Hope to pick up members in the process
- **Round Table**
    - David K mentioned the molding machine at Epcot previously sponsored by the SPI. Maybe if still running it could be a good partnership opportunity for IMD. David O mentioned he knows people at RJG and will find out what is going on.
    - Adam mentioned he knows people who might want to serve on the board. Will invite some people for future meetings. It was suggested we circulate a short bio before the meeting, and maybe to invite them for a short session instead of the entire meeting that goes a long time.
    - Jack wants to call meetings with the committees that serve below them on a monthly basis.

Next Meeting

Next meeting to be communicated by Ray at a future time. Tentatively looking at the Sunday during the ANTEC.

Adjournment

Motion: Jim moved to adjourn the meeting. Pete seconded. Meeting was adjourned at 4:21 pm.

IMD Leadership

DIVISION OFFICERS

IMD Chair
Sponsorship Chair
TPC ANTEC 2020
David Okonski
General Motors R&D Center
david.a.okonski@gm.com

Treasurer
Jim Wenskus
wenskus1@frontier.com

Secretary, Education Chair, Reception Chair and TPC ANTEC 2017
Srikanth Pilla
Clemson University
spilla@clemson.com

Technical Director
Peter Grelle
Plastics Fundamentals Group, LLC
pfgrp@aol.com

Past Chair
Adam Kramschuster
University of Wisconsin-Stout
kramschustera@uwstout.edu

Erik Foltz
The Madison Group
erik@madisongroup.com

Councilor, 2014 - 2017
Susan E. Montgomery
Lubrizol Advanced Materials
susan.montgomery@lubrizol.com

BOARD OF DIRECTORS

TPC ANTEC 2015
Chair Elect
Raymond McKee
Sonoco
Raymond.Mckee@sonoco.com

TPC ANTEC 2016
Education Committee Chair
Srikanth Pilla
Clemson University
spilla@clemson.com

TPC ANTEC 2018
ANTEC Communications Committee Chair
Rick Puglielli
Promold Plastics
rickp@promoldplastics.com

TPC ANTEC 2019
David Kusuma
Tupperware
davidkusuma@tupperware.com

Membership Chair
Nick Fountas
JLI-Boston
fountas@jli-boston.com

Engineer-Of-The-Year Award
Kishor Mehta
Plascon Associates, Inc
ksmehta100@gmail.com

Awards Chair
HSM & Fellows
Lih-Sheng (Tom) Turng
Univ. of Wisconsin — Madison
turng@engr.wisc.edu

Assistant Treasurer
Nominations Committee Chair Historian
Hoa Pham
Freudenberg Performance Materials
hp0802@live.com

Jack Dispenza
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IQMS
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Brad Johnson
Penn State Erie
bgj1@psu.edu

Michael C. Uhrain IV
Sumitomo
michael.uhrain@dpg.com

EMERITUS

Mal Murthy
Doss Plastics
Dosscor@gmail.com

Larry Schmidt
LR Schmidt Associates
schmidtlra@aol.com

IMD New Members

The Injection Molding Division welcomes 65 new members…

Felipe R. Angeles Torres
Dave Armstrong
Kate L. Biter
Mahmoud Bubakir
Jose Ramon Cano
Ramon Cardona
Genaro Castillo Tinajero
Jorge Chacon
Kevin Joel Chambers
Jae Hyuk Choi
Russell Bryan Cote
Thomas M. Cunningham
Bill Darnell
Julio C. de la Cruz Valdez
Larry A. Drake
Eric Dummitt
Matthew Entwistle
Jim Farwell
Joel Flores
Loren Friend
Debby L. Gomez
Gangjian Guo
Ravindra Gupta
Gerold Hackenbracht
Francis Michael Jack
Brian Kautzman
Joshua Evan Kelley
Mike Kerwood
Blake Kittridge
Eason Kong
Wilbert A. Ku Vargues
Cynthia Hope Lane
Christopher Laverty
Scott Lew
Lauren Litwa
John MacKenzie
L. Giselle Magallon Martinez
Sudhakar Manchala
David A. Manera
Paul Massicotte
Timothy McArthur
Nicole McCall
Darrell McGuire
Craig Miller
Vishal Modi
Amir Nabati
Kennedy Ogila
Jose Olvera
Roberto Perez
Sam F. Redick
Justin David Ritter
Nate Robinson
John Rowe
Kenny Saul
Patrick Spence
Steve Stoltz
Semi Su
Kevin Sullivan
Ladislao Torres
Guadalupe Villarreal
Lee Vogelsberg
Yuan Wen
Jake Whitta
Luis Zamora Varela
Hao Zhang

…from 8 countries:

Australia
Canada
China
Germany
India
Mexico
South Korea
U.S.A.
apan
Mexico
New Zealand
Panama
Saudi Arabia
Spain
U.S.A.

IMD New Members Continued

...representing more than 60 organizations including:

A. Raymond Tinnerman
A. Schulman
Albea
Alcon
AmericanMade Plastics
Anderson Technologies
Applied Medical Technolgies
Ark-Plas Products Inc.
ASYST Technologies LLC
Bayer
Becton Dickinson
Beijing U. of Chemical Technology
Bennett Precision Tooling Pty. Ltd.
Bradley U.
Canterbury Engineering
Comar LLC
Creative Plastic Concepts LLC
Criser
Custom Plastic Solutions LLC
Delta Systems Inc.
Dura Automotive Systems LLC
Eastone Mold Industrial Ltd.
Faurecia Interior Systems
Free Enery Inc.
General Motors Corp.
Intech Services
Keith Manufacturing
Kokuyo Camlin Pvt. Ltd.
L.K. Systems
LG Electronics
Marsh & McLennan
Mercer Process Equipment
MGS Manufacturing Group
Microbac Labs
MTD Products
Neutrex Inc.
NiFAm Science and Industrial Inc.
North System LLC
Osram Sylvania
P.M.G. Engineering
Philips Healthcare
Plasai
Plastic Components Inc.
Polymer Technology & Services LLC
Precise Mold & Plate
Primaplas Pty. Ltd.
Prism Plastics
SHS Plus GmbH
SSW Holding Company Inc.
Star Thermoplastics
Steinwall Inc.
Tecnipol SA de CV
Trinseo
Uniform Color Co.
U. Massachusetts - Lowell
Valeo Sistemas Electronicos
Wastequip
Western Washington U.
Yanfeng USA
Zhejiang Rotoun Plastic Technology Co. Ltd.

Society of Plastics Engineers

6 Berkshire Blvd., Suite 306
Bethel, CT 06801-1065 USA

Membership Application

PH: 203-775-0471 • Fax: 203-775-8490
www.4spe.org • membership@4spe.org

Contact Information *Please print clearly*

First Name (Given Name) ______ Middle Name ______

Last Name (Family Name) ______

Company Name/University Name (if applicable) ______

Mailing Address is: ☐ Home ☐ Business Gender: ☐ Male ☐ Female (for demographic use only)

Address Line 1 ______

Address Line 2 ______

Address Line 3 ______

City ______ State/Province ______

Country ______ Zip/Postal Code ______ Phone ______

Preferred Email (This will be your member login and is required for usage of online member services) ______

Alternate Email ______

Date of Birth (*Required* for Young Professional membership) ______

Graduation Date (*Required* for Student membership) ______ Job Title ______

Membership Types *Check one*

☐ **Student: $31** (Graduation date is required above)
☐ **Young Professional: $99** (Professionals under the age of 30. Date of birth is required above)
☐ **Professional: ~~$144.00~~ $129** (Includes $15 new member initiation fee)

Choose 2 *free* Technical Division and/or Geographic Section Member Groups. →

1. ______ 2. ______

Additional groups may be added for $10 each. Add Special Interest Groups at no charge.

1. ______ 2. ______
3. ______ 4. ______

Dues include a 1-year subscription to *Plastics Engineering* magazine-$38 value (non-deductible).
SPE membership is valid for 12 months from the date your membership is processed.

Payment Information

Payment must accompany application. No purchase orders accepted.

☐ Check Enclosed Amount ______

Charge: ☐ Visa ☐ Mastercard ☐ American Express Expiration Date: ______

Account Number: ______

Amount Authorized: ______ CSC#: ______ Last 3 digits from the back of MC/Visa. 4 digits from the front of AMEX.

Cardholder's Name (as it appears on card): ______

Signature of Cardholder: ______

Payment by Wire Transfer Instructions

You **must** include account number +ABA number + bank fees. Please include the Member ID# and Name so we may apply payment to the correct person.

USD: WELLS FARGO: 108 Federal Road, Danbury, CT 06811 USA
ACCT #2040607562129 ABA #121000248 SWIFT CODE #WFBIUS6S

EURO: HSBC Bank: 9 Penn Road, Beaconsfield, Buckinghamshire HP9 2PT UNITED KINGDOM
ACCT #70841841 IBAN #GB03MIDL40051570841841 SWIFT CODE #MIDLGB22 SORT CODE #400515

The SPE Online Member Directory is included with membership. Your information is automatically included unless you indicate otherwise.

______ Exclude my email address from the Online Membership Directory
______ Exclude all my information from the Online Membership Directory
______ Exclude my address from 3rd party mailings

By signing below, I agree to be governed by the Bylaws of the Society and to promote the objectives of the Society. I certify that statements made in the application are correct and I authorize SPE and its affiliates to use my phone, fax, address and email to contact me.

Signature ______ Date ______

Technical Division Member Groups - Connect with a global community of professionals in your area of technical interest.

☐ Additives & Color Europe - D45
☐ Automotive - D31
☐ Blow Molding - D30
☐ Color & Appearance - D21
☐ Composites - D39
☐ Decorating & Assembly - D34
☐ Electrical & Electronic - D24
☐ Engineering Properties Structure - D26
☐ European Medical Polymers - D46
☐ European Thermoforming - D43
☐ Extrusion - D22
☐ Flexible Packaging - D44
☐ Injection Molding - D23
☐ Medical Plastics - D36
☐ Mold Making & Mold Design - D35
☐ Plastics Environmental - D40
☐ Polymer Analysis - D33
☐ Polymer Modifiers & Additives - D38
☐ Product Design & Development - D41
☐ Rotational Molding - D42
☐ Thermoforming - D25
☐ Thermoplastic Materials & Foams - D29
☐ Thermoset - D28
☐ Vinyl Plastics - D27

Geographic Section Member Groups - Network with local industry colleagues.

☐ Alabama/Georgia-Southern
☐ Australia-New Zealand
☐ Benelux
☐ Brazil
☐ California-Golden Gate
☐ California-Southern California
☐ Caribbean
☐ Carolinas
☐ Central Europe
☐ Colorado-Rocky Mountain
☐ Connecticut
☐ Eastern New England
☐ Florida-Cental Florida
☐ Florida-South Florida
☐ France
☐ Hong Kong
☐ Illinois-Chicago
☐ India
☐ Indiana-Central Indiana
☐ Iowa
☐ Israel
☐ Italy
☐ Japan
☐ Kansas City
☐ Korea
☐ Louisiana-Gulf South Central
☐ Maryland-Baltimore-Washington
☐ Mass/New Hampshire-Pioneer Valley
☐ Mexico-Centro
☐ Michigan-Detroit
☐ Michigan-Mid Michigan
☐ Michigan-Western Michigan
☐ Middle East
☐ Mississippi
☐ Nebraska
☐ New Jersey-Palisades
☐ New York
☐ New York-Rochester
☐ North Carolina-Piedmont Coastal
☐ Ohio-Akron
☐ Ohio-Cleveland
☐ Ohio-Miami Valley
☐ Ohio-Toledo
☐ Oklahoma
☐ Ontario
☐ Oregon-Columbia River
☐ Pennsylvania-Lehigh Valley
☐ Pennsylvania-Northwestern Pennsylvania
☐ Pennsylvania-Philadelphia
☐ Pennsylvania-Pittsburgh
☐ Pennsylvania-Susquehanna
☐ Portugal
☐ Quebec
☐ Southeastern New England
☐ Spain
☐ Taiwan
☐ Tennessee-Smoky Mountain
☐ Tennessee Valley
☐ Texas-Central Texas
☐ Texas-Lower Rio Grande Valley
☐ Texas-North Texas
☐ Texas-South Texas
☐ Tri-State
☐ Turkey
☐ United Kingdom & Ireland
☐ Upper Midwest
☐ Utah-Great Salt Lake
☐ Virginia
☐ Washington-Pacific Northwest
☐ West Virginia-Southeastern Ohio
☐ Western New England
☐ Wisconsin-Milwaukee

Special Interest Groups - Explore emerging science, technologies and practices shaping the plastics industry. Choose as many as you would like, at no charge.

☐ Advanced Energy - 024
☐ Alloys and Blends - 010
☐ Applied Rheology - 013
☐ Bioplastics - 028
☐ Composites Europe - 026
☐ Extrusion Europe - 025
☐ Failure Analysis & Prevention - 002
☐ Joining of Plastics & Composites - 012
☐ Marketing & Management - 029
☐ Nano/Micro Molding - 023
☐ Non-Halogen Flame Retardant Tech. - 030
☐ Plastic Pipe & Fittings - 021
☐ Plastics Educators - 018
☐ Plastic in Building and Construction - 027
☐ Process Monitoring & Control - 016
☐ Quality/Continuous Improvement - 005
☐ Radiation Processing of Polymers - 019
☐ Rapid Design, Eng. & Mold Making - 020
☐ Thermoplastic Elastomers - 006

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Message from the Publisher

Seeking authors!

As you may know, each newsletter contains articles, technical papers and sponsorships by individuals and companies who kindly provide their expertise to be published and shared with SPE. This newsletter strives to get the newest information to our readers. I'd like to open up our search for authors who would like to be a valued part of our newsletter as a columnist. Each issue will contain a specific topic of interest to the members.

If you or anyone you know is interested in providing a column for each issues for areas such as:

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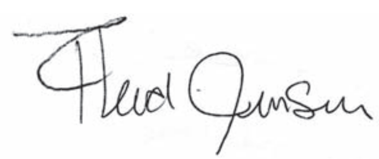
Maintence
Hot Runners
Business Updates

or any other specialty you can provide please send me an e-mail with your ideas.

Thank you all, stay in touch!



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