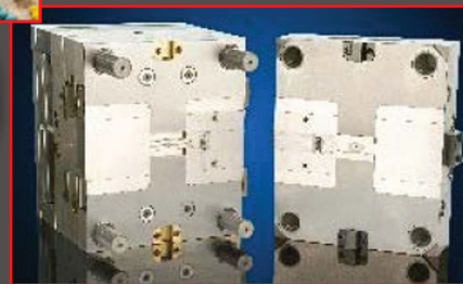
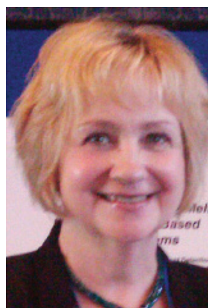
Fall 2012 | No. 91



MOLDING VIEWS

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

Chair's Message



Autumn Greetings!

Technical programming is a paramount focus area for our Injection Molding Division Board of Directors (IMD BOD). We earnestly support student activities, scholarships and continuing education opportunities for our IMD membership. Our goal is to provide vehicles to support your growth and fulfillment in your professional roles. The IMD BOD, along with SPE, is actively organizing webinars, seminars and conferences for our global membership.

ANTEC is the premier annual technical conference. Mark your calendars for:

SPE ANTEC® 2013
April 22-24
Duke Energy Convention Center
Cincinnati, Ohio, USA

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Chair's Message Continued

Our IMD outstanding paper review team, consisting of Pat Gorton, Technical Program Chair (TPC) for ANTEC 2013, Pete Grelle (Technical Director), Erik Foltz (IMD BOD Chair- Elect) and Adam Kramschuster, Technical Program Chair (TPC) for ANTEC 2014, are busy making preparations for this conference. Pete Grelle enthusiastically commented, "ANTEC is of great benefit since the latest in plastic industry innovations are introduced at the conference. You can't afford to miss out on the chance to exchange information about what is going on in the plastics industry and the numerous networking opportunities that ANTEC provides."

The deadline for papers has been extended until Monday, November 26, 2012, 5PM EST. You can submit your papers at http://antec2013.abstractcentral.com

We look forward to receiving papers in the areas of tooling, materials, processing, simulation and others. It is the superb quality of your contributions that make ANTEC a success!

The IMS BOD would greatly appreciate your feedback regarding technical programming. We encourage you to submit your ideas for topics you feel would be beneficial.

Best regards,
Susan Montgomery
Chair, IMD BOD

Industry Events Calendar

Click the show links for more information on these events!

January 2013

21-23:
Molding 2013: Technologies for Business Success—23rd International Conference
New Orleans, LA
http://www.executive-conference.com/conferences/mold13.php

February 2013

24-27:
International Polyolefins Conference 2013 "The Renaissance of Polyolefins"
Houston, TX
http://www.spe-stx.org/conference.php

March 2013

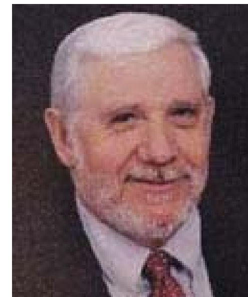
6-7:
Additives and Color Europe 2013 Conference
Königswinter-Bonn, Germany
http://netforum.avectra.com

20-22:
GPEC® 2013 Conference
New Orleans, Louisiana
http://www.4spe.org
Hilton Houston North, Houston, TX

April 2013

22-24:
ANTEC 2013
www.spe4.org
Duke Energy Convention Center

Ask the Experts: Bob Dealy



Injection Molding: Test Information on Plastic Flow Lengths

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: I've read articles that plastic will flow further in aluminum alloy molds. Is there any definite test information that confirms that flow lengths increase in molds built from aluminum or other materials over steel?

A: I too have heard stories and read articles where material supplier experts state that flow lengths can be increased by using either aluminum or copper alloys when compared to steel in their molds. However, I have never been able to either confirm or duplicate conditions where plastic flow length can be changed by using a different mold material.

What we know for sure is that materials with higher thermal conductivity, typically aluminum and copper alloys, will maintain a more consistent mold surface temperature, reduce the thermal range of the cavity and core surface during the injection molding process and return the surface temperature to the desired set point quicker after injection. These attributes will typically result in reduced cooling times and overall molding cycles, but don't necessarily affect plastic flow lengths.

We also know that differences in surface roughness, length and dimensions of the plastic feed system, mold surface finish and/or change of direction and the radii used will affect the flow of plastics. If no other process changes are made, then it's difficult to understand how flow length can be affected.

Ask the Experts: Bob Dealy Continued

Definitely the four major injection molding parameters could affect plastic flow length, the parameters are understood to include; 1. Plastic temperature; 2. Plastic flow rate; 3. Plastic pressure and; 4. Plastic cooling time and/or rate. The plastic cooling time and/or rate is the only parameter that comes into play for this question. However, logic tells us that a material with a higher thermal conductivity rate will cool the plastic faster and this should result in less rather than greater flow length.

It is difficult to exactly duplicate molding conditions to make direct comparisons when conducting molding tests to confirm a marketing and/or technical claim. Any change in plastic melt temperature, viscosity, injection speeds, times and pressures plastic material or mold heating or cooling times can influence flow characteristics. I'm of the opinion that claims related to mold materials and plastic flow lengths, have more to do with processing differences in comparison testing than the cavity and core alloy.

As always, if any of our readers know of any rules of thumb or can offer additional advice, please write me at MoldDoctor@DealeyME.com

Bob Dealy
Dealy's Mold Engineering

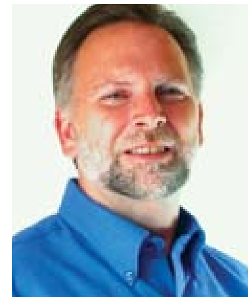
Do You Have an Issue With Injection Molding?

Send you question to the Dealy's Mold Engineering

MoldDoctor@DealeyME.com

Ask the Experts: Terry L. Schwenk

Hot Runner Questions



The purpose of this column is to provide valid information concerning hot runner technology. We invite you to submit questions or comments to our hot runner expert, Terry L. Schwenk has over 35 years of processing and hot runner experience.
Terry is currently employed with EWIKON Molding Technologies and can be reached by mailing: terry.schwenk@ewikonusa.com.

Q: How do thermocouples work?

A: A thermocouple consists of two conductors of different materials (usually metal alloys, one being ferrous and one being non-ferrous) that produce a voltage in the vicinity of the point where the two conductors are in contact. The voltage produced is dependent on, but not necessarily proportional to, the difference of temperature of the junction to other parts of those conductors. In contrast to most other methods of temperature measurement, thermocouples are self powered and rquire no external form of excitation. The main limitation with thermocouples is accuracy system errors of less than one degree celsius can be difficult to achieve.

Any junction of dissimilar metals will produce an electric potential related to temperature.

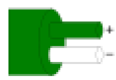
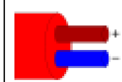
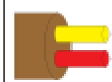
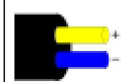
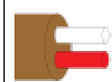
There are several types of thermocouples; however we will just discuss two in this article. Certain combinations of alloys have become popular as industry standards. Selection of the combination is driven by cost, availability, convenience, melting point, chemical properties, stability, and output. Different types are best suited for different applications. They are usually selected based on the temperature range and sensitivity needed. Thermocouples with low sensitivities (B, R, and S types) have correspondingly lower resolutions. Other selection criteria include the inertness of the thermocouple material and whether it is magnetic or not. "J" and "K" thermocouple types are listed below with the positive electrode first, followed by the negative electrode.

Type K (chromel {90% nickel and 10% chromium}—alumel {95% nickel, 2% manganese, 2% aluminum and 1% silicon}) is one of the most common general purpose thermocouple. It is inexpensive, and a wide variety of probes are available in its −200°C to +1250°C / -330°F to +2460°F range. Type K was specified at a time when metallurgy was less advanced than it is today, and consequently characteristics may vary considerably

Ask the Experts: Terry L. Schwenk Continued

between samples. One of the constituent metals, nickel, is magnetic; a characteristic of thermocouples made with magnetic material is that they undergo a deviation in output when the material reaches its Curie point. This occurs for type K thermocouples at around 350 °C.

Type J: (iron–constantan) has a more restricted range than type K (−40 to +750°C), but higher sensitivity. Refer to chart for the color codes of the various conductors.

	Temperature range °C (continuous)	IEC Color code	BS Color code	ANSI Color code
K	0 to +1100			
J	0 to +750			

In the area of hot runner technology, the "J" type thermocouple is the most popular. However, depending on which part of the world you are located will determine the color coding of the conductors. When tools are imported or transferred to different countries, it can be confusing. One thing to remember, the positive lead is always magnetic.

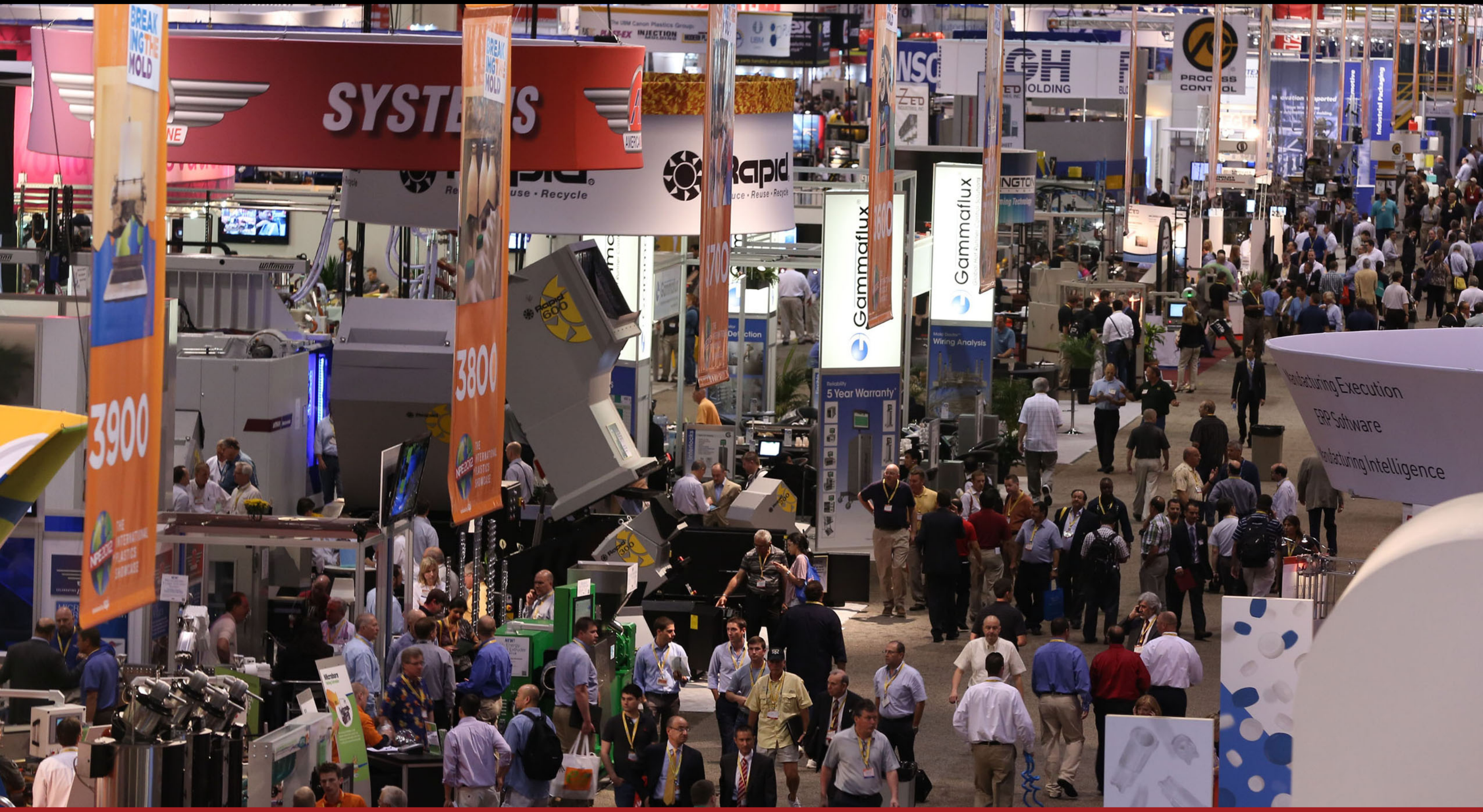
There are key items to keep in mind when using thermocouples. You want to keep the number of connections to a minimum. Each connection creates a resistance. The more resistance you have between the sensing point and the temperature controller the more likely you have an erroneous reading. Most new temperature controllers on the market have a cold junction compensation to correct errors. If the signal is too weak, the temperature controller can not make the correction accurately. Care must be taken when installing the thermocouple to make sure it senses when you want it to sense. If the two conductors contact each other anywhere besides the sensing point at the tip of the thermocouple the position where the conductors make contact now become the new sensing position. If the wire is pinched between the mold plates that is where the thermocouple will sense temperature.

Thermocouples can come in two varieties, grounded and un-grounded. The use of un-grounded thermocouples is preferable. Reason being they are easier to troubleshoot with a voltage meter. Checking one of the conductors to ground will tell you immediately if you have pinched the thermocouple wire or if it has been damaged. If it becomes necessary to splice a conductor, it is important to use thermocouple wire to ensure the signal is maintained.

Terry L. Schwenk *EWIKON Molding Technologies*

SEND IN YOUR HOT RUNNER QUESTION OR TIP TO:
E-mail Terry Schwenk at terry.schwenk@ewikonusa.com

CALL FOR TECHNICAL PAPERS



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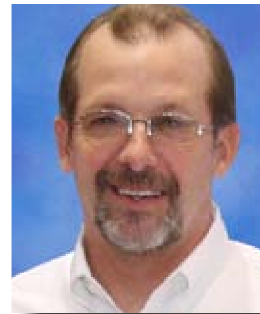
Questions or to submitt a paper:

Pat Gorton, IMD TPC: pgorton@energizer.com • Barbara Spain, Online Program Specialist: bspain@4spe.org

Ask the Experts: Steve Johnson



All the Right Stuff

Please submit any questions or comments to maintenance expert **Steve Johnson**, *Operations Manager for ToolingDocs LLC, and owner of MoldTrax.*

Steve has worked in this industry for more than 32 years. E-mail Steve at steve.johnson@toolingdocs.com or call (419) 281-0790.

Q: Our business is picking up and I need to hire two more repair technicians to work on our multi-cavity molds.

The problem is that our local talent pool has dried up, so I've got to run an ad and I'm not really sure what requirements to post. Most everyone here is telling me we want someone like a toolmaker or a machinist – others mention different skills. Any suggestions?

A: Congratulations on your business picking up and having such a great problem! Finding a skilled trade's person who has all the right stuff and is a good match for the type of tools you run plus handling your shop culture can be a daunting task. Contrary to popular belief, this person will most likely not be a journeyman toolmaker. Here are some things to consider when on the hunt for a good mold repair person.

Availability of Experienced Technicians

You are not the only one experiencing the pain of trying to replace or hire a technician that will learn to repair and maintain your tools efficiently and safely plus learn as quickly as possible. Boomer-techs are moving on everyday and taking valuable maintenance experience with them that is impossible to replace—unless a continuous improvement and training theme runs strong in your company.

The factors that dictate the eventual value level of maintenance candidates can be divided into two areas:

- what the candidate comes in with (potential) and
- what they learn through the "OJT Effect" (OJT = On the Job Training).

Here are five intangibles that we try to gage the level of during interviews:

Potential

- **Interest in the job**—More than just a paycheck, the person is motivated and enjoys the challenge and rewards of working on mechanical things with hundreds of parts

Ask the Experts: Steve Johnson Continued

- **Good Work Ethic**—driver vs. a cruiser, a team player, wants to increase skills and get better and seeks ways to improve
- **Mechanical Intuition**—good mechanical vision, understands leverage and mechanical motion/forces that wear out tooling
- **Physical Skills**—uses hand tools effectively and is versed in several trade skills like welding, electrical, using precision measuring tools; good connection from head to hands
- **Systematic Approach**—naturally methodical in bench habits vs. the "scarecrow" style of work where no real method—only chaos--exists.

Getting a handle on these intrinsic skills can be extremely difficult based on how well prospective employees interview and your particular style of interviewing. We can test for points three and four but the rest might not be revealed for several weeks after employment and after the "OJT Effect" begins to take hold.

Ask the Experts: Steve Johnson Continued

The "OJT Effect" (Is a Powerful Force)

The "OJT Effect" can be a boon or a cancer on new employees, raising the skill level of mediocre employees or sucking the life from really good ones. Even armed with good hand/bench skills, this person will need to learn specific mold and part defects/issues that occur with each of your tools which takes time. For some it may take longer than others.

The type of molds you run and the culture of your shop will have a bearing on your decision about what type of tech to hire. Your OJT environment is critical to the development of new techs and the speed that even experienced techs understand your molds, product specs, typical defects and corrective actions. Most of the time, we have them "follow Bob around" hoping they get it right. Hopefully, you have good maintenance manuals for all your tools that will considerably shorten the learning curve, and related stress.

Here is a breakdown of a few of the factors that contribute to the OJT Effect:

- **Mold Type**
  Are your molds high cavitation, hot runner, and close tolerance tools molding critical medical parts with difficult engineering resins? Or single cavity 2-plate tools molding dog food bowls? The more complex they are the longer the time frame it is to learn them and the higher the skill level needed to work on them. Large molds, even though simple in design, are difficult just because of the size.

- **Typical Mold and Part Defects**
  Lots of tooling means lots of areas for mold component problems. It makes troubleshooting part defects difficult. Large molds, even though they may be simple in design, are often difficult to repair and maintain simply because of their size or the size of the part.

- **Corrective Actions**
  Once a probable cause is determined, will they have appropriate training from peers to learn the proper repairs, sequences tips and techniques and what molds need to run?

- **Attitude, Working Environment**
  How well do they fit in with the current group (including management)? Will the prevailing shop culture enhance and motivate a new repair tech or demoralize him/her, adding to the overall mediocre shop performance?

There are many more factors that contribute to overall shop culture and the OJT Effect but they are too numerous to mention here. The point is that they all demonstrate the potential differences between the shop that simply hires a person who seems to have the right stuff, then throws them into the fire expecting good results vs. the shop that has a deliberate course of training to get newbie's up to speed.

The Short Answer

Not thinking it through could lead one to believe that all you need is a person who has good mechanical intuition, appears to really like the job and has some kind of experience working on or building molds. Anything else is a plus.

Ask the Experts: Steve Johnson Continued

But today's lean shops don't have the time to make hiring missteps that are based on poorly worded or misleading ads, so it pays to look at your specific mold and product requirements to make sure you get the right caliber technician in your shop.

Look Inside First

My first suggestion would be to take a hard look at your process technicians, mold set-ups and even those in Q/A whose DNA is mechanical in nature as candidates. They already possess the knowledge of the parts you run and processing/mold issues with running them, which is a great head start! Some of the best injection mold repair technicians I know also have sound processing experience, which allows them to "recognize" various mold conditions (plastic flow paths, cooling, etc.) that can affect the quality of the part and the performance of the mold.

Mold Repair Skills Requirements

While many mold repair tasks are mold/product specific, the same basic troubleshooting logic and foundational skills are needed with all molds, regardless of type, style or size. Some are just more difficult than others, requiring a greater degree of focus, precision, organization and sometimes manpower.

To get this person, many companies assume (incorrectly) that only journeyman toolmakers qualify as skilled repair technicians, and want to see extensive machining experience on the resume. Granted, knowledge of tool making nicely dovetails with the job of mold repair in specific situations, but on a day-to-day basis, mold/part defect troubleshooting skills, mold function knowledge and hand/bench skills are much more critical to the success of mold maintenance technicians, and the molds they maintain. Journeyman toolmakers usually dislike mold repair, as their skill is in machining, fabrication and CNC work are not fully utilized.

New Age Maintenance Technician

As molding technology advances around us, so should our maintenance and repair training techniques. To stay current, we must recognize that the experiences and typical skills of the young person today is not the same as 10 or 20 years ago, and can't be trained in the usual OJT manner. Back then, kids were fixing up and maintaining their hot rods, motorcycles, lawnmowers and other mechanical things that in many cases were crucial to their economic or social lively-hood. So many came started with good hand tool skills.

Conversely, today's kids are more versed in computers, video games, technological wizardry and other things not related to hand tool skills or keeping mechanical things operating. So this side of the job (bench

Ask the Experts: Steve Johnson Continued

ergonomics, leverage, control, etc.) needs to teach as opposed to just showing them what tool to use. That said, at our training facility we get many young folks showing a real desire and talent to work with their hands and they pick up bench work extremely fast.

If training aids (maintenance manuals that contain tech tips, probable causes of issues with specific instructions during the 8 Stages of Repair) are part of a shop's systemized approach, the new employee will be brought up to speed much more quickly, more accurately and with a solid maintenance foundation on which to build their skills over time

Here are 3 levels of a Mold Repair job description that one company uses. All new employees come in as "C" level until they meet the qualifications of the higher level. This not only gives a new, experienced tech something to shoot for but also keeps things fair in the toolroom.

Mold Repair Job Description

Mold Maintenance "C" (Apprentice)

1. Possess good mechanical aptitude and basic hand tool experience.
2. Ability to aid in the moving, disassembly, cleaning and troubleshooting of molds and components in a safe and methodical manner and possess the basic tools, physical skills and discipline to use specific prescribed methods/procedures during this work. Could be called upon to handle simple in-press cleanings, and lubrication of molds.
3. Understands the importance of accurate, legible documentation and follows prescribed methods/procedures during work.
4. Recognizes and enjoys the challenges of this trade and demonstrates a willingness to learn and a desire to advance.

Mold Maintenance "B" (Intermediate)

1. Has acquired the necessary maintenance knowledge and skills to safely, effectively and efficiently disassemble, clean, troubleshoot and assemble 50% -75% of company's active molds.
2. Demonstrates sound mechanical reasoning, knowledge of mold function and a desire to improve plastics processing knowledge as it relates to mold function.
3. Can measure and calculate basic (static) tooling stack-ups to determine component preloads, clearance or to verify print dimensions.
4. Is familiar with hot runner function, basic maintenance and troubleshooting techniques such as probe tip cleaning, removal, reworking and basic electrical troubleshooting on probes, heaters, thermocouples and manifolds.
5. Demonstrates the ability to work methodically and meticulously during repairs on molds.
6. Inputs clear, concise data entries into mold maintenance manuals.
7. Has acquired the necessary hand tools and operating skills for BASIC machine shop equipment, (grinder, mill, lathe, micrometers, calipers etc.)

Ask the Experts: Steve Johnson Continued

Mold Maintenance "A" (Advanced)

1. Has acquired the necessary knowledge, skills and tools to effectively and efficiently disassemble, clean, troubleshoot/repair and assemble 95% of company's active molds. Capable of utilizing all in-house machine shop equipment to rework worn or damaged tooling and to fabricate simple tooling.
2. Demonstrated that their molds start and run productively without repeated pulls for missing or incorrectly installed tooling components, or repeating mold/part defects.
3. Capable of complete dimensional mold tooling stack-out (static and dynamic) to determine tooling component preloads, clearance and fits utilizing any/all available prints.
4. Capable of determining "best" methods/procedures to institute mold/part defect probable causes, corrective and preventative actions of shop personnel and has excellent knowledge of typical mold functions.
5. Works in a steady, professional manner with little or no supervision required.
6. Enthusiastic and interacts well in training less skilled or new employees in proper mold maintenance techniques and methodology.
7. Has acquired a sound understanding of plastics processing requirements for molds such as venting, heating, cooling, polishing, nozzle, sprue, and runner configuration and steel plating applications or requirements.
8. Continuously seeks to improve knowledge base by attending conferences, seminars or exhibitions directed towards the designing, building and maintenance of molds.

Bonus Skills:

- Computer experience
- Welding, brazing, MIG and TIG experience
- Hot runner experience on various styles
- Mold design or building experience

Steve Johnson *ToolingDocs LLC, and owner of MoldTrax.*

Do You Have Question or Problem You Need Resolved?

If you have a question on MOLD MAINTENCE?

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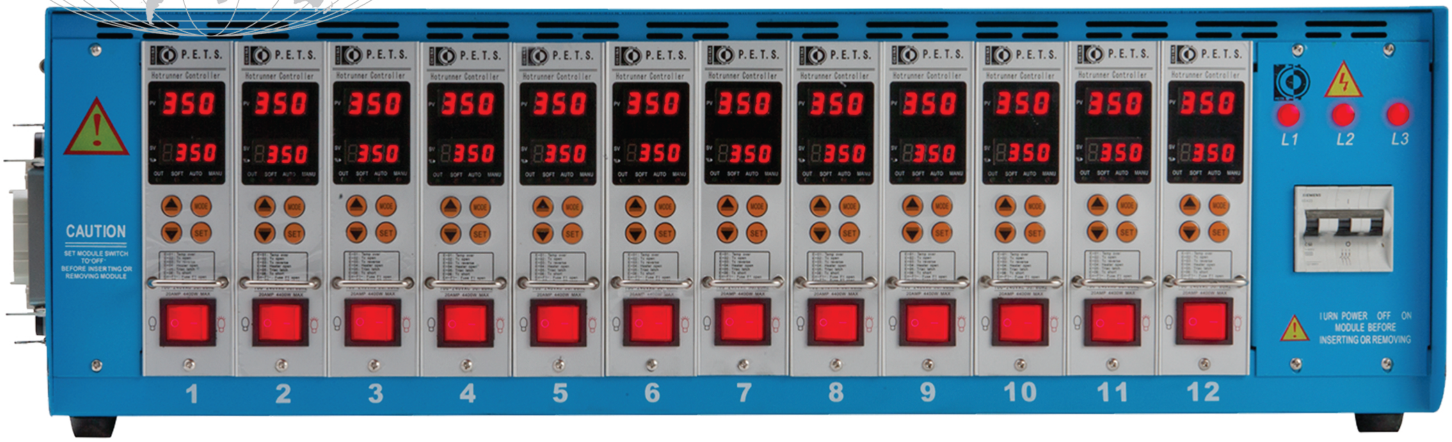

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Energy Saving Must be Carefully Considered

Even though many companies have already implemented measures to increase energy efficiency, by and large there is still a lot of catching up to be done. Those responsible often balk at the higher investment costs for new purchases and conversions, or doubt the actual savings potential. But that is short-term thinking.

To effectively reduce the energy costs in injection molding, all the influencing factors must first be included in the balance sheet. This calculation must not only consider the energy costs that occur "directly at the machine". The complete system must be considered, from delivery of the plastic molding compound to delivery of the finished product (including the building and infrastructure) . That is the only way to implement integrated energy efficiency measures and generate competitive advantages.

If we consider a production operation with entirely hydraulic machinery, the energy consumption breaks down into between 45 and 50 % for machine drives, 10 to 15 % for cylinder heating and around 20 % for temperature control and cooling of the mold. The energy outlay required in a conventional injection molding shop for compressed air generation, material transport, drying and lighting makes up 10 % of the total consumption.

Independently of the part and the processing conditions, the energy costs for manufacturing an injection molded part make up between 3% (for technical parts) and 7% (for packaging). Because of these low values, processors have not thought enough about the possibilities of energy saving in the past. In view of the extreme increases in raw materials and energy prices, it is worth bearing in mind that a reduction of the specific energy demand increases the processor's own profitability and operating results.

Requirements on the Process Control

A good start is for the operating personnel to look for the correct machine setting in the process control, that is to say a stable operating point with a short cycle time and low energy consumption while maintaining the part quality. The magnitude of the energy saving depends strongly on the nature of the part and on the manufacturing process. The energetically optimum operating point can be determined by changing the machine settings; to recognize the effect of a variation of the parameters, the operating personnel need aids. For example, watt meters (external or directly integrated into the machine) can determine the current power consumption. The findings obtained must be assessed in conjunction with the cycle time (capacity planning) and the part quality achieved.

In an example that illustrates the effects of different machine settings on the specific energy requirement for one part and one material (**Figure 1**), the changes hardly affected the cycle time at all. The graph shows that, for example, an increase in screw speed produces a high instantaneous power consumption, but the metering process is shortened and the specific energy demand for the cycle is thereby comparatively lower than for the standard setting. The back pressure serves to aid uniform melting of the molding compound and can be adapted depending on the melt homogeneity and uniformity of the metering process. However, too high a backpressure can also effect an extension of the metering process and thereby an increase of the specific energy consumption [1].

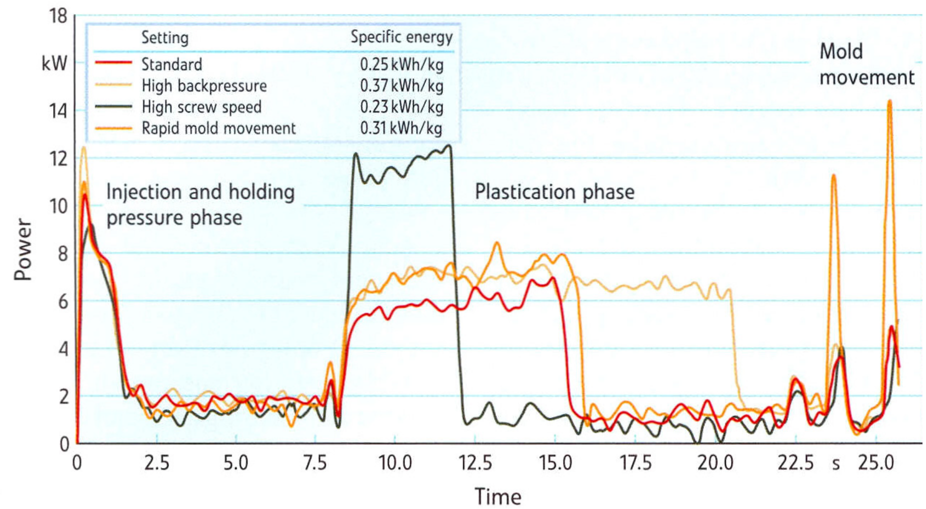

Figure 1: Power consumption over a cycle with variation of the machine parameters (1). Changes in the settings only had a small influence on the cycle time

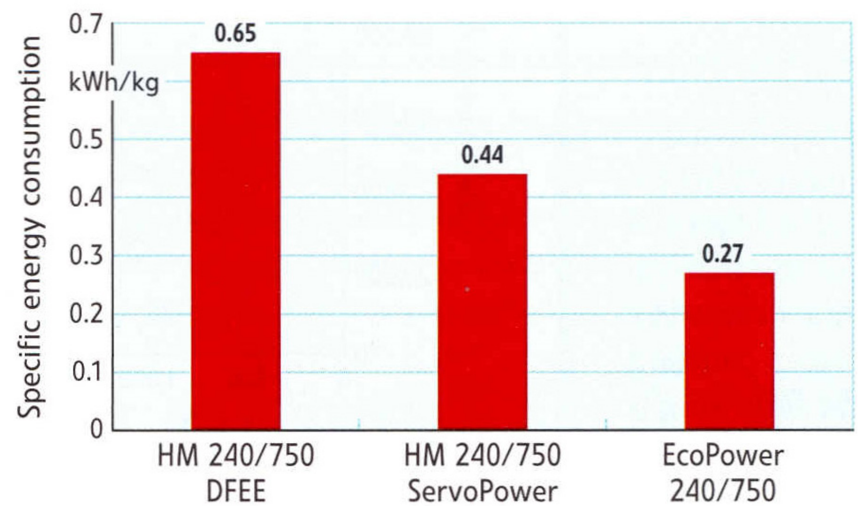

Figure 2: Specific energy consumption dependent on the drive system. The mode of operation of the three machines with clamping forces of 2,400 kN each was measured for the same test conditions and process parameters (cycle time:20 s; shot weight: 120 g)

Amortization of Expensive Drives

When energy efficient injection molding is mentioned nowadays, the topic of "all-electric injection molding machines" is unavoidable. The energy-saving potential of all-electric machines, depending on the application, is usually close to 50%, and in some cases up to 70% compared to hydraulic machines. The higher investment costs must be seen in the perspective of current electricity prices, so that the purchase of an all-electric injection molding machine pays off after only a short time. The fact that standard-model electric machines can perform parallel movements is another advantage compared to hydraulic machines.

In the case of hydraulic machines, servo drive technology with constant pumps is gradually superseding the drives that have so far been used with electronic control pumps. As a result, the energy consumption, depending on the machine size, can be reduced by an order of up to 30%. An in-house study at Wittmann Battenfeld showed that, compared to a hydraulic machine (Battenfeld model HM 240/750 DFEE), the use of a servo drive

Feature: Energy Savings in Injection Molding Continued

	HM 240 DFEE	HM 240 ServoPower	EcoPower 240
Effective energy costs – difference	100.00 %	–32.44 %	–57.19 %
ROI (due to extra costs of investment)	–	2.94 years	2.31 years
Remaining operating life after ROI (at 10 years)	–	7.06 years	7.69 years
Additional contribution margin due to lower energy costs (after 10 years)	–	**23,720 EUR**	**45,600 EUR**

Table 1: A monetary analysis of different drive systems (base: 6,000 production hours) reveals the saving potential of the servomotor and electromechanically driven machines compared to the all-hydraulic versions

(HM 240/750 ServoPower) in this application (**Figure 2**) lowers the specific energy demand by about a third, and an electromechanical machine (EcoPower 240/750) by as much as 57%.

Despite the higher purchasing costs of the Servo Power and EcoPower series, the ROI for these two drive systems can be seen to payoff after 35 and 28 months running time respectively, solely because of the lower energy costs (**Table 1**). This calculation also includes a monetary consideration of the energy costs for an assumed machine running time of ten years. The use of these energy saving drive systems, in this example, increases the contribution margin by 23,720 EUR for hydraulic machines with servo drive and by 45,600 EUR for all-electric machines.

Insulating the Screw Cylinder and Injection Mold

The cover plates mounted on the screw cylinder reduce the heat emission and convection, while protecting employees against burns on direct contact with the heating strip. Since, during heating and operation, the screw cylinder radiates a considerable amount of heat to the environment as power loss, this loss can be stemmed by installing or retrofitting insulating sleeves (Title photo) This involves specific advantages:

- Energy consumption reduced by up to 40%,
- Increased work safety,
- Shorter heating times,
- Longer lifetime, and
- Easy to install or even to retrofit.

Temperature-controlled molds inevitably transmit heat via the individual mold plates to the mold mounting platens. The user can counteract this by fastening heat-insulating plates at the fixed and movable mold halves. In general, heat insulating plates (between the mold and machine mounting platens) can yield energy savings at temperatures below 10 and above 40°C. Above 80°C, full insulation should be taken into account from an energetic point of view, in a similar way to molds for silicone and rubber processing (**Figure 3**).

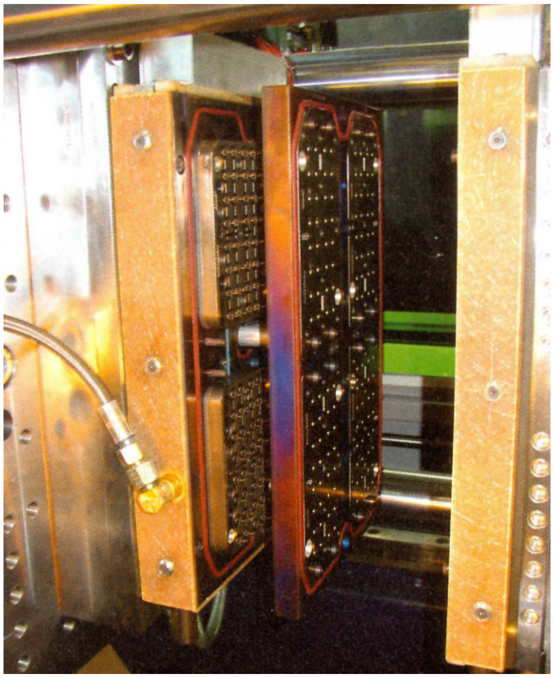

Figure 3: The cavity regions of a mold heated to about 200°C for processing liquid silicone rubber are completely encased in heat insulation panels

Mold mass m [kg]	Heat energy Q [kJ]	Required heating performance [kW]
4,000	110,400	30.7
3,000	82,800	23.0
2,000	55,200	15.3
1,000	27,600	7.7
500	13,800	3.8

Table 2: Heat energy and heating power for different mold weights can be calculated with a simple equation

Partial Mold Temperature Control

Heating an injection mold requires a certain amount of thermal energy. If heat is supplied to a body, the absorbed thermal energy Q is proportional to the mass m and the resulting temperature increase delta T of the body. Taking the material constant Cp, measured in J/(g. K), the following is obtained:

Q= cp • m . f..T

cp: specific heat capacity

cp (steel) : 0.46 kJ/(kgK)

If we consider the thermal energy, which is required for heating the mold and maintaining a constant mold temperature, it quickly becomes clear that the main parameter is the mass m of the mold. Heating a 4 t injection mold from room temperature to 80°C can be seen to require heat energy of 110.4 MJ (**Table 2**). For one hour's heating time, this consumes 30.7 kWh.

If the mass to be heated is reduced by only partially heating the mold, the consumption is reduced linearly (**Figure 4**). This can be performed by installing installation plates between the cavity area and the residual mold mass. This saving is particularly noticeable in single-shift production, where the molds are cooled at the end of the working day and must be heated up to the working temperature again with the next production start [2] .

Feature: Energy Savings in Injection Molding Continued

Avoiding Extremes

It is worthwhile working through injection molding processes in detail, since the energy losses that used to be regarded as inevitable can be reduced in the short term. Equally important is a long-term strategy to replace energy-intensive processes and energy consumers, or eliminate them if possible. Analysis of the entire material flow -from delivery of the pellet stock to the packaged plastic part - is thereby essential for energy-optimized production.

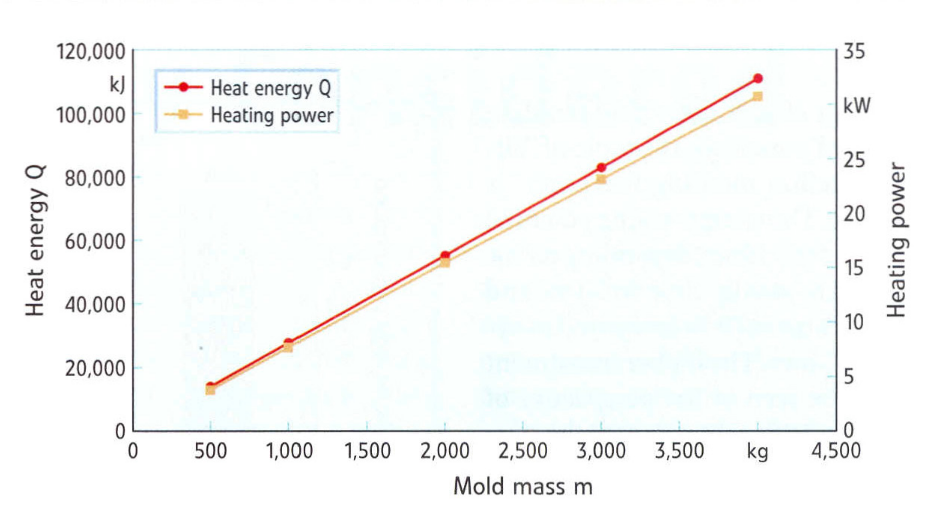

Figure 4: The heat energy required to heat an injection mold and the heating power fall with the mold weight

The energy consumption of injection molding production is determined by the configuration of the production system. The use of energy-saving drives, particularly from directly driven electrical axes, can often almost halve the energy consumption compared to conventional all-hydraulic systems. An important role in this is played by the choice of machine size. For each application, the clamping unit must be combined with a suitable injection unit and the appropriate drive technology to form a system that operates energy efficiently and with the necessary process accuracy. With ancillary equipment, too, correct dimensioning and power consumption must be observed.

Adapted process control can reduce the energy consumption. That means that the machine optimization must be subject to "consumption control" with suitable metering equipment. Anyone looking at the settings in detail can often see that the clamping force and injection pressure are controlled to the maximum, the cylinder temperatures at the upper limit and the movements are running jerkily. In general, such extremes can considerably increase the energy consumption. The physical relationship is obvious: generating a given pressure, for example with a hydraulic pump, requires a particular amount of energy. If a higher pressure is set, more energy is required accordingly. Extreme values in the settings should always be examined to see whether they are justifiable, and changed if possible .

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Tough Requirements on Soft Parts

System solutions for liquid silicone products in medical technology and pharmaceutics

Around a quarter of all liquid silicone products are utilized in the fields of medical technology or pharmaceutics, and the trend is rising sharply. As well as replacing other materials, silicone opens the door to innovative administration forms and product designs whilst opening up new possibilities for implant technology, among other things.

Silicone offers high mechanical and chemical stability; it can withstand both very high and low temperatures, requires no plasticizers, can be disposed of in an environmentally acceptable manner and offers outstanding biocompatibility. It is easy to see why the material is finding its way into more and more areas of medical engineering – even if, as a raw material, it is more expensive than other elastomers. Processing generally involves liquid silicone, which is also known by the abbreviation LSR (liquid silicone rubber). We can define five application groups which have varying market potential and which also differ in terms of their product requirements on manufacturing technology. (**Figure 1**)

The largest group (which also has the biggest market) is traditional medical technology, with products that address the needs of hospitals and medical practices. These include disposable items such as valve elements for infusion and transfusion and dialysis filter seals, which are produced in very large quantities using large molds with as many as 256 cavities. One driver of growth in this market is product functionality, which is continually improving thanks to the use of innovative materials.

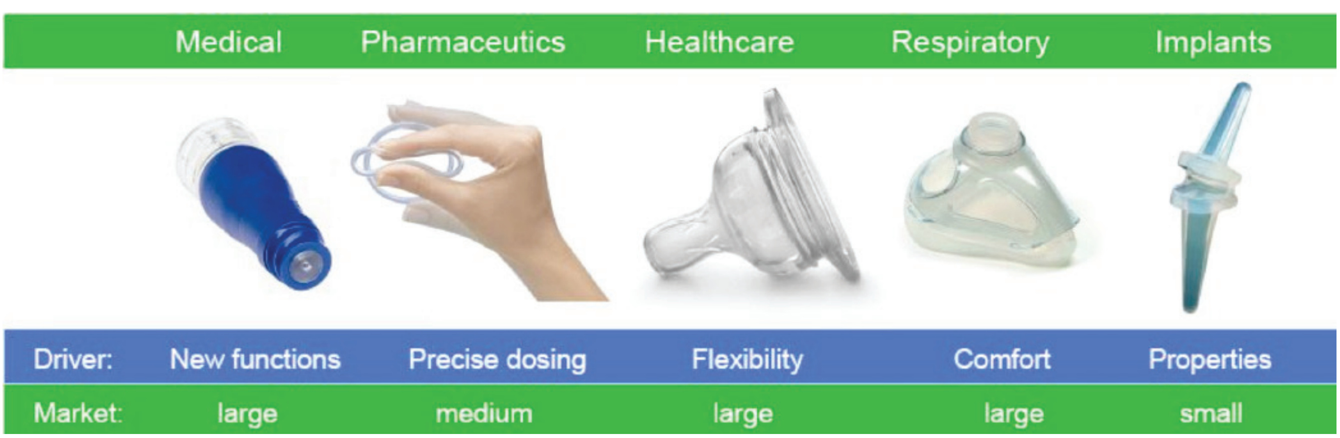

Figure 1: The market can be divided into five application groups with varying potential and differing product requirements on manufacturing technology.

Figure courtesy of ICU Medical, MSD, iStock, Laerdal, DePuy Orthopaedics.

Feature: Tough Requirements on Soft Parts Continued

The second-largest market is healthcare, with products such as nipples for babies' bottles. Since this market is characterized by shorter product lifecycles, it places particularly high demands on the flexibility of production facilities.

Another large (and rapidly expanding) market is the field of respiration technology. This field generally requires relatively large parts such as respiratory masks, which are manufactured in molds with fewer cavities. The main growth driver here is the need for greater comfort in application.

Pharmaceutics and implant technology make up smaller, highly specialized markets. These two areas are relatively new disciplines for silicone technology, so many new developments are expected to emerge in the next few years as the market expands. Despite this, both areas will continue to lag behind the larger established markets in terms of volume for many years to come. Silicone products are increasingly being utilized in the field of pharmaceutics to release precise dosages of active agents into the body over an extended period; one example of such a product is the contraceptive vaginal ring. An example in the field of implant technology would be finger joint prostheses made of liquid silicone.

Case Study: Medical Technology

The number of dialysis patients is on the rise: some two million people around the world are reliant on external blood purification equipment. Filters with semi-permeable membranes that remove metabolic toxins from the blood are used for this process. These filters, such as those produced by Fresenius Medical Care, comprise of various polymer materials; the sealing rings are made of liquid silicone. Disposable, mass-produced dialysis filters have vast potential: each filter requires two o-rings, and every one of the two million patients needs 2-3 dialysis sessions per week.

Despite high safety standards and routines, caregivers often sustain needlestick injuries. To minimize this risk, hospital suppliers such as ICU Medical, B. Braun and Becton Dickinson provide connectors for the needle-free transfer of solutions to ports or infusion valves. Needle-free connectors are already a requirement for new systems in the USA, so this product is now well established as a lucrative mass-produced item for plastics processing companies and OEMs. Silicone is employed so that systems can be used for transferring blood as well as alcohol-based active agent solutions, lipids, antiseptics such as chlorhexidine and chemotherapeutics.

Case Study: Respiration Technology

Medical practitioners believe that more than ten percent of all people suffer from circadian rhythm sleep disorders. Over the past decade, there have been great strides in the diagnostic and therapeutic options for this illness. There remains a focus on enhancing the wearing comfort of masks for CPAP (continuous positive airway pressure) therapy, which aims to treat apnoea during sleep.

Feature: Tough Requirements on Soft Parts Continued

These masks are generally manufactured from a combination of thermoplastic and elastomer. This is because the mask needs to fit comfortably and provide proper sealing around the nasal area to ensure the respirator can function correctly. The sealing components that come into contact with the skin usually comprise of plasticized PVC, which is increasingly being replaced by silicone because of the difficulty in disposing of PVC products. The mask manufacturer Laerdal, to give one example, has already switched to LSR; the company produces soft components using an ENGEL victory injection molding machine and a four-cavity Rico mold.

Aside from CPAP masks, respiratory masks are now being produced from silicone for use in intensive care.

Figure 2: Silicone vaginal rings release specified quantities of hormones over extended periods. Figure courtesy of DePuy Orthopaedics.

Case Study: Pharmaceutics

Silicone is also suitable for utilization within the body thanks to its excellent biocompatibility – and the pharmaceutical industry is taking advantage of another property of the material. Its three-dimensional molecular structure provides a space in which active agents may be stored, which means silicone products are capable of releasing agents over an extended period without changing their own structure. The USA is leading the way in developing applications for this new form of administration, and a number of products are now available in Europe as well. In Germany, for example, MSD is marketing the NuvaRing, a silicone vaginal ring that prevents ovulation by releasing hormones. This product consequently constitutes a new form of birth control. Similar products are used in the field of veterinary medicine, for example with a view to synchronizing livestock cycles. (**See figure 2**)

Administration forms based on new kinds of silicone product are also being developed in the ophthalmology field. Products in the pipeline include tiny dosing dispensers that can be directly inserted into the tear duct. These are designed to deliver a precise dosage of medication, which is problematic where eye drops are concerned because an undefined quantity of an active agent will be flushed out again with lachrymal fluid.

Figure 3: Since it can withstand high mechanical stresses, silicone is an ideal material for prosthetic finger joints.
Figure courtesy of DePuy Orthopaedics.

Case Study: Implants

In the case of arthrosis and rheumatism, implantable prosthetic joints made of silicone can restore movement to the fingers of patients. Neuflex implants by DePuy are amongst the brands already on the market. Silicone products offer better properties than conventional prostheses based on titanium alloys and thermoplastics. (**See figure 3**)

A second example would be valves implanted in the eye beneath the cornea to drain aqueous humor; these products are marketed as Ahmed glaucoma valves. They prevent excess pressure in the eye which can lead to glaucoma. The silicone product also plays a role in averting the post-operative complications that have been known to arise in the implantation of conventional drainage systems.

Challenges in Silicone Processing

The main demands as regards the manufacture of silicone products are that they must be fully automatic, low in burrs and require no reworking. Production facilities in the medical engineering field must also fulfil the requirements of the FDA, GMP and GAMP (where applicable). System solutions provided by suppliers who can deliver the machine, the automation and other system components precisely coordinated to one another, with the whole system inclusive of documentation and ready to use, are becoming increasingly significant in this sector. At its parent plant in Schwertberg in Austria, systems supplier ENGEL operates a clean room where it continually develops machine and automation concepts for the medical engineering field and produces tailor-made solutions in partnership with its customers.

Figure 4: In the plastics processing field, expertise in clean room production will be even more of a competitive advantage owing to the rise in pharmaceutical applications. Figure courtesy of ENGEL.

Injection molding machines suitable for clean room environments have smooth, easy-to-clean surfaces, covered guide rails, grease-free tie-bars, sealed drilled holes in the mold mounting platen. Measures are also taken to minimize particle load and heat emissions, such as enclosed drives and injection cylinder suction removal. The injection molding machines are either fully enclosed in the clean room, or the clamping unit (including parts handling) forms an enclosed clean room. (**See figure 4**)

The molds for LSR processing in the clean room must be well insulated. In contrast to thermoplastics processing, the injection units are cold in the production of silicone products but the molds are hot; without insulation, this would cause turbulence in the ambient air. The low viscosity of the raw materials places another demand on molds: they must be highly precise to reliably prevent burr formation.

The injection molding machines must also operate with extreme precision, not only to prevent burr formation but to guarantee secure parts handling. For this reason, the most popular machines in the ENGEL product range for the medical engineering field are those in the ENGEL e-motion, ENGEL e-victory and ENGEL victory series; fully electric ENGEL e-motion machines are also gaining ground. Since they offer completely oil-free operation, these machines ensure very high process reliability for a clean room.

In the medical engineering area, hydraulic machines are preferably equipped with servohydraulic ecodrive; compared to standard hydraulic machines, they reduce energy consumption by up to 70 percent. Given the long cycle times of 20 seconds or more, energy savings (and thus cost savings) are especially significant in the case of LSR processing. In addition, servohydraulics improve positioning accuracy and reduce the heat load in the machine environment.

Although silicone parts are light and shatterproof, automatic removal from molds is standard in medical engineering: this is the only way to ensure cavity separation, which is important in terms of the sector's requirement for traceability. Compressed air should not be used during part removal because the costs of compressed air cleaning would impair the cost-effectiveness of the process.

LSR products will normally be tempered before leaving the clean room. Ideally, the tempering furnace acts as a kind of lock between the clean room and the unregulated production area. The products are tempered at 200°C for around four hours to remove volatile matter such as monomers or oligomers. Products are not usually washed because this would require clean air which is time-consuming and costly to produce.

Of all silicone products for the medical engineering market segment, pharmaceutical products and implants – from raw materials to the final packaged product – are the most demanding in terms of the production process and logistics. Where a silicone product facilitates administration of an active medicinal agent, plastics processing companies are acting in the manner of pharmacists: the active agents, dispensed together with the LSR components, are handled on the premises of the plastics processing company. Expertise in clean room production, utilizing innovative and cost-effective procedures, is therefore set to become evenly more firmly established as a fundamental competitive advantage in plastics processing.

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Investigation of Supercritical Fluid-Laden Pellet Injection Molding Foaming Technology (SIFT)

A novel method of producing injection molded parts with a foamed structure has been developed. Compared with conventional microcellular foaming technologies, it lowers equipment costs without scarifying the production rate, making it a good candidate for mass producing foamed injection molded parts. In this study, further research on this method was conducted including: (1) comparison of different physical blowing agents, (2) shelf life of carbon dioxide laden pellets, and (3) optimization of the process conditions.

Introduction

Microcellular injection molding is one of the special injection molding processes. The idea of microcellular foaming was first conceived at MIT in the 1980s. Later, Trexel Inc. combined the idea of microcellular foaming with the injection molding process and commercialized it as the MuCell process [1]. It continues to attract attention because it saves on material costs and improves produc-tion efficiency compared with conventional solid injection molding.

Microcellular injection molding requires specially design-ed supercritical fluid (SCF) delivery and dosing systems to be installed for the delivery of the physical blowing agent (PBA). Modifications need to be made on the regular injection molding machine(s) for the installation of supercritical fluid (SCF) delivery devices. These two factors lead to an increase in capital investment, especially when a large number of injection molding machines need to be modified. It would be desirable to reduce these costs in order to realize the benefits of microcellular injection molding across a wider range of applications more cost-effectively.

Alternatively, chemical blowing agents (CBA) can be used to produce foamed injection molded parts without the need of installing any additional equipment. However, residuals tend to appear in the parts after the reaction, which leads to the degradation of the polymer matrix and might contaminate the mold [2]. Furthermore, the use of chemical blowing agents does not allow for good control over the foaming process or the porosity of the parts [3]. In addition, it is not suitable for processing high tempera-ture polymers due to its early decomposition [4].

Another way to achieve foaming using a conventional in-jection molding machine is to saturate pellets with a physical blowing agent in a high pressure vessel first, and then use them for injection molding [5]. A cellular foam structure can be achieved, but the disadvantage is that the production rate of pre-saturated pellets using a high pressure vessel is usually not high enough for continuous mass production of injection molded parts.

A novel method to produce microcellular injection molded parts without any of the aforementioned shortcomings was proposed by Lee et al. [6], and is known as Supercritical-fluid-laden-pellet Injection-molding Foaming Technology (SIFT). Using this method, gas-laden pellets can be pro-duced by an extruder equipped with a gas injection device. Modification and device additions are only needed for one extruder, and the gas-laden pellets produced can be used by multiple conventional injection molding machines to produce light-weight foamed parts without any modifi-cation or additional equipment for the injection molding machines. The feasibility and effectiveness of this method have been verified through preliminary studies [6].

In order to deepen the understanding of SIFT and to fur-ther improve its reliability, this study investigated the following aspects: (1) comparison of different physical blowing agents, (2) shelf life of carbon dioxide laden pellets, and (3) optimization of SIFT process conditions.

Experimental Setup

A schematic of the experimental setup is shown in **Figure 1** (page 28) [6]. The gas-laden pellets were produced using an Extrudex EDN 45-30 single screw extruder. Gas was injected into the extruder barrel using a Teledyne ISCO 260D high precision syringe pump, which is capable of precisely maintaining gas injection at either constant pressure or constant volumetric flow rate, such that the gas flow rate and gas content can be calculated. A gas injector made of a micro-pore sintered metal (7 micron pore size) was flush mounted into the extruder barrel in the middle section to inject the gas into the barrel while preventing polymer backflow. The injected gas was mixed into the polymer to form a single-phase polymer-gas solution in the extruder. The solution was then extruded through a 12-orifice filament die. Once the strands came out of the die, they went into a cold water bath to be cooled down immediately in an effort to prevent foaming and a loss of gas from the strands. The strands were then pelletized using an Extrudex SGS 100-E pelletizer. The pellets were oven dried to remove moisture content and then stored in plastic zipper bags. Once the gas-laden pellets were pro-duced, they could be taken to injection molding machines to produce foamed parts. The injection molding machine used in this study was an Arburg Allrounder 320S. The resin used in this study was 95% LDPE (Marlex, Chevron Phillips Chemical Company) with 5% green colorant. It has a melt index of 25g/10 min and a density of 0.925 g/cm_3. Both carbon dioxide (CO_2) and nitrogen (N_2) were used as blowing agents.

IMD Best Paper Continued

Comparison of SIFT using CO_2 and N_2

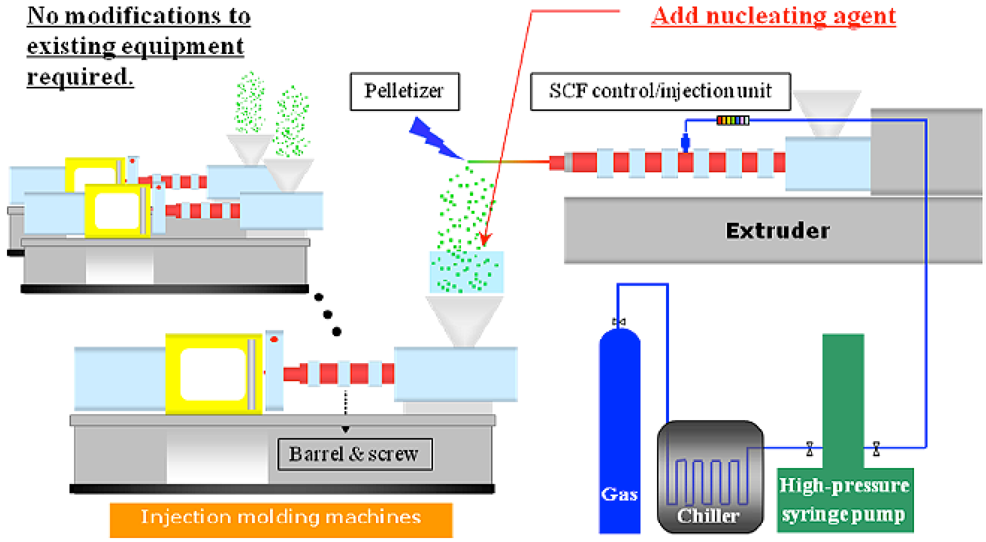

Figure 1: Schematic of SIFT extrusion/injection molding [2].

Carbon dioxide (CO_2) and nitrogen (N_2) are the two most commonly used physical blowing agents in plastic foam-ing processes. Both have been successfully applied in microcellular injection molding. The resulting part qualities—such as microstructure and surface quality—were quite different due to different gas properties in the plastic matrix. For SIFT, carbon dioxide was used in a study by Lee et al. [6], while nitrogen had not been tried before. In this study, a comparison between nitrogen and carbon dioxide as the blowing agent for SIFT was conducted.

Some key physical properties of nitrogen and carbon dioxide under typical process conditions are listed below in **Table 1**. As shown in the table, carbon dioxide has a density 5.3 times larger than that of nitrogen, suggesting that in order to have a fair comparison of the same mass flow rate during gas dosing, as well as an equal amount of initial gas content in the pellets, a much lower volumetric flow rate has to be set on the syringe pump for carbon dioxide. In LDPE, carbon dioxide has a solubility almost 7 times larger than that of nitrogen, which means more carbon dioxide can be readily dissolved into the polymer matrix. The diffusion coefficient of carbon dioxide is one magnitude smaller than that of nitrogen, indicating that carbon dioxide tends to diffuse out of the polymer matrix much more slowly than nitrogen.

Table 1: Key Physical Properties of N_2 and CO_2.

Properties	N_2	CO_2
Density@ 3 deg. C & 130 bar (kg/m^3)	170.8	902.3
Solubility @ 180 deg. C & 120bar (g/g) [7,8]	0.011	0.075
Diffusion coefficient in LDPE @ 188 deg. C (cm^2/sec) [9]	1.5×10^{-4}	1.1×10^{-5}

SIFT experiments were conducted using both carbon dioxide and nitrogen. The gas flow rate was set at 1.54g/min, which does not exceed the solubility limit of either carbon dioxide or nitrogen given an extruder throughput of 250g/min on average. By using nitrogen as the blowing agent for SIFT, foamed injection molded parts were produced. As shown in **Figure 2**, with a 3 hour shelf life after SIFT extrusion, the injection molded parts showed a typical swirled surface and a foamed structure inside, which indicates sufficient gas content in the nitrogen-laden pellets. The weight reduction was 6%. Therefore, nitrogen is a feasible blowing agent for SIFT and can be used to produce light-weight, foamed injection molded parts.

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Three levels of shelf life were carried out through studying the foaming behavior of purged melt using either nitrogen or carbon dioxide as the blowing agents: 3 hours after extrusion, 40 hours after extrusion, and after drying the pellets in an oven at 90 °C for 12 hours to simulate an extended shelf-life period. The pellets were then melted and purged out of the injection molding machine barrel, where the cell size at the center section of the purged ma-terial was then used as the criterion for measuring the remaining gas content in the pellets. A larger cell size implies a higher gas content because of the further cell expansion in the open air when the gas content is high. As shown in **Figure 3**, for carbon dioxide, the cell size does not change much between the three hour and 40 hour shelf life, with both conditions resulting in a heavily swirled part surface after injection molding due to the high gas content. After the oven treatment, it was found that the cells became smaller, and the part surface showed less swirl marks, suggesting a substantial decrease in gas content.

For nitrogen, initially with a three hour shelf life, the cell size was similar to that of using carbon dioxide. However, after a 40 hour shelf life, a significant decrease in cell size can be seen, which is due to the higher diffusivity of nitrogen in LDPE as compared with carbon dioxide. After the oven treatment, the cells became very small and sparse, and the injection molded parts showed neither swirl marks on the surface nor cells inside of the part. Furthermore, the parts were short shots, suggesting insufficient gas content.

From this comparison, we see that at the same gas mass dosage, using carbon dioxide as the blowing agent will yield a longer shelf life due to lower diffusivity, and is therefore a better choice in terms of shelf life. Moreover, carbon dioxide can be liquefied by using a chiller at 3°C before dosing while nitrogen is much more difficult to liquefy. Physical blowing

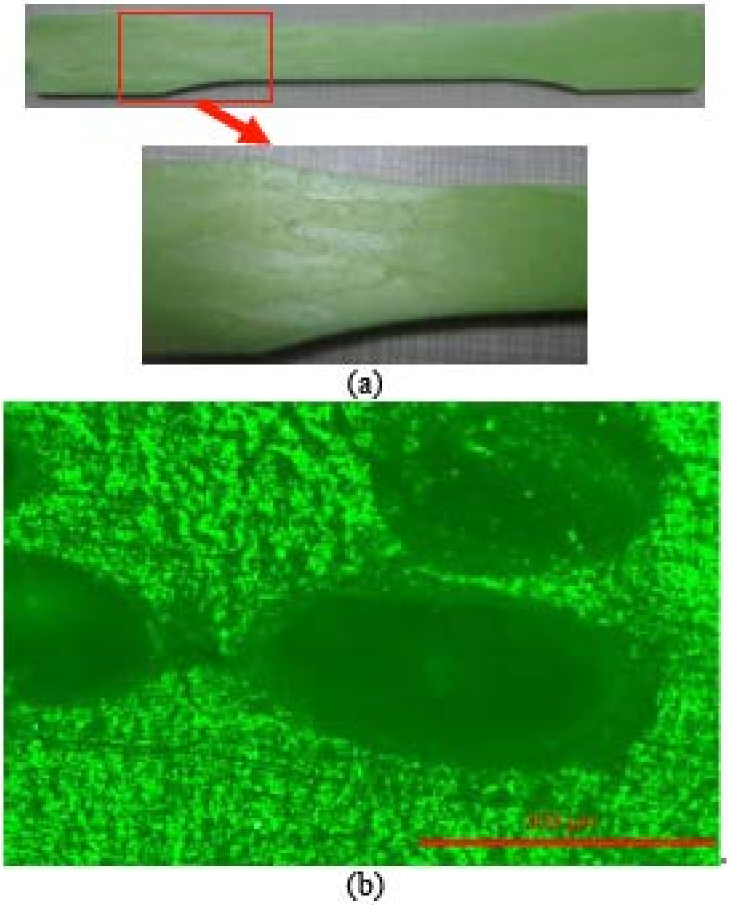

Figure 2: SIFT part (a) surface and (b) morphology with nitrogen as the blowing agent. Scale bar in (b) is 300 µm.

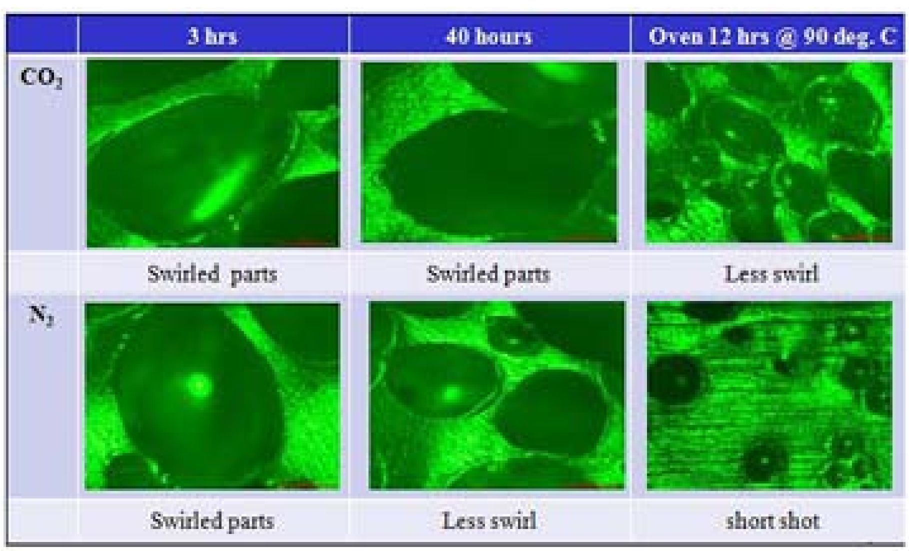

Figure 3: Shelf life comparison of SIFT using CO_2 and N_2.

agents in liquid form make the metering and dosing much easier and more accurate in the syringe pump as compared to gas blowing agents. Overall, both carbon dioxide and nitrogen can be used for SIFT to create light-weight foamed injection molded parts.

Shelf Life Study of CO_2-Laden Pellets

Since carbon dioxide was found to be a more suitable choice in terms of shelf life due to ease of metering and foaming capability, a more in-depth shelf life study was carried out for SIFT using carbon dioxide as the blowing agent. Four different gas injection flow rates were tested to give different gas content levels in the pellets, starting from 0.5 g/min to 1.6 g/min. The shelf life evaluated started from 1 hour after SIFT extrusion to up to two weeks after extrusion. Whether or not foamed parts could be produced was used as the criterion to judge if the remaining gas content in the pellets was sufficient. As can be seen in **Table 2**, for the gas flow rates tested, the pellets lasted for at least 24 hours and still produced foamed parts. For the 0.5 g/min shelf life study, after 48 hours, the parts produced looked like solid parts, suggesting that the gas content was no longer sufficient. As the gas flow rate increased, the shelf life lengthened. For the 1.3 and 1.6 g/min flow rate conditions, foamed parts could still be produced after being stored for 14 days. In summary, using a higher gas flow rate is beneficial to prolonging the shelf life of the gas-laden pellets.

Table 2: Shelf Life of CO_2 laden Pellets (F=Foamed, S=Solid).

Gas Flow Rate (g/min)	Shelf Life					
	1 hour	24 hours	48 hours	72 hours	6 days	14 days
0.6	F	F	S	S	S	S
0.9	F	F	F	F	F	S
1.3	F	F	F	F	F	F
1.6	F	F	F	F	F	F

SIFT Optimization

One of the objectives of this study was to determine the influence of SIFT process parameters on part quality, as well as the optimal process conditions. Therefore, a design of experiments (DOE) was performed. The process para-meters investigated included the gas flow rate during SIFT extrusion, shelf life of the pellets, polymer injection speed, and polymer shot volume during SIFT injection molding. The design was a 4-factor, 2-level full factorial design, with a total of 16 different combinations of process con-ditions, as shown in **Table 3** and **Table 5** (page 32).

The quality indices evaluated included surface quality, weight reduction, shrinkage, and short shots. Dong's method was used for the analysis with a significance level of 10%. The outcome of the DOE is shown below in **Table 4** and **Table 5 (**page 32**)**.

Table 3: SIFT Design of Experiments (DOE).

	Injection Molding		Extrusion	
Level	Injection Speed (cm^3/sec)	Shot Volume (cm^3)	Gas Flow Rate (g/min)	Shelf Life
Low	40	9.7	0.36	0.5 Hour
High	80	11	0.55	1 Day

As shown in **Table 4**, the shot volume plays an important role in determining the weight reduction and preventing short shots and shrinkage. Higher gas flow rates prolong the shelf life of the gas-laden pellets and prevent shrinkage but cause more swirl marks on the part surface. Higher injection speeds reduce short shots. A longer shelf life leads to a better surface quality but more part shrinkage.

Table 4: Design of Experiments (DOE) Analysis Results.

Outcome		Factors
Wt. reduction	**is affected by**	Shot volume (–)
Surface quality		Gas flow rate (–) , Shelf life (+), Gas flow rate X Shelf life (+)
Short shot		Injection speed (–), Shot volume (–), Injection speed* shot volume (+)
Shrinkage		Shot volume (–), Gas flow rate (–) , Shelf life (+), Gas flow rate X Shelf life (+)

To achieve the optimization objective of maximizing weight reduction, we started from condition #8 in **Table A1**, reduced the shot volume from 11 cm^3 to 10.28 cm^3, and introduced 0.01s of packing. Under this condition, a weight reduction of 7.1% can be achieved without causing shrinkage and short shots. However, due to the large gas content, the surface showed swirl marks. To ensure a good surface quality, an intermediate level of gas flow rate is required, and very likely the weight reduction will need to be compromised.

Conclusions

In this study, the feasibility of using nitrogen as a physical blowing agent for SIFT was verified. A comparison be-tween using nitrogen and carbon dioxide as the blowing agent revealed that carbon dioxide is more suitable for SIFT because of easier metering and dosing and a better shelf life. A shelf life study of up to 14 days was performed on carbon dioxide laden pellets with various gas content levels. To ascertain the influence of process parameters on SIFT part quality, and to determine optimal processing conditions, a design of experiments was carried out. It was found that a weight reduction of up to 7.1% can be achieved with adequate surface quality.

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Table 5: Design of Experiments (DOE) Outcomes.

Standard Order	Factors				Outcomes			
	Inj. Speed (cm^3/sec)	Shot Volume (cm^3)	Gas flow (g/min)	Shelf Life	Weight Reduction	Surface	Shrink	Short
1	40	9.7	0.4	0.5 hr	10.05%	Good	Severe	Severe
2	80	9.7	0.4	0.5 hr	7.01%	Good	Severe	Minor
3	40	11	0.4	0.5 hr	4.67%	Good	Minor	No
4	80	11	0.4	0.5 hr	4.83%	Good	Minor	No
5	40	9.7	0.65	0.5 hr	11.37%	Swirl	No	Severe
6	80	9.7	0.65	0.5 hr	8.72%	Swirl	Minor	Minor
7	40	11	0.65	0.5 hr	4.98%	Swirl	No	No
8	80	11	0.65	0.5 hr	5.61%	Swirl	No	No
9	40	9.7	0.4	1 day	11.84%	Good	Severe	Severe
10	80	9.7	0.4	1 day	8.57%	Good	Severe	Minor
11	40	11	0.4	1 day	5.30%	Good	Minor	No
12	80	11	0.4	1 day	5.61%	Good	Minor	No
13	40	9.7	0.65	1 day	11.99%	Good	Severe	Severe
14	80	9.7	0.65	1 day	9.19%	Good	Severe	Minor
15	40	11	0.65	1 day	4.98%	Good	Minor	No
16	80	11	0.65	1 day	6.23%	Good	Minor	No

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Key Words: microcellular injection molding, microcellular extrusion, carbon dioxide.

IMD Board of Directors Meeting

August 24, 2012 | Teleconference

Submitted by Hoa Pham, Secretary

Welcome

Chair Susan Montgomery called the meeting to order at 12:13 PM ET, and welcomed all attendees.

Susan appointed Rick Puglielli and Srikanth Pilla to the Board, with term ending at ANTEC 2013.

Roll Call

Present were:

Susan Montgomery (Chair), Jim Wenskus; Peter Grelle; Hoa Pham; Pat Gorton; Erik Foltz, Adam Kramschuster; Jack Dispenza, Nick Fountas; Larry Schmidt; Jeremy Dworshak, David Kusuma; Mal Murthy (Emeritus), Raymond McKee, Kishor Mehta, Rick Puglielli, Sreekanth Pilla.

Guests were: Jon Ratzlaff (EC Liaison) Barbara Spain(SPE Staff) , Sarah Sullinger (SPE Staff), and Ram Thanumoorthy (3M).

Absent were:

Lee Filbert, Tom Turng, Michael Uhrain, David Okonski

This constituted quorum.

Approval of April 1, 2012 Meeting Minutes

Motion: *Peter Grelle moved that the April 1, 2012 meeting minutes be approved, as written and distributed. Jack Dispenza seconded and the motion carried.*

Financial Report – Jim Wenskus, Treasurer

Financial figures from July 1, 2011 through June 30, 2012 were reviewed. Jim reported that the financial status has been healthy, with the SPE rebate on target, and the newsletter sponsorships steady.

Expenses were reviewed. Jim noted that the IMD had pledged at the Gold level to sponsor the Student Activities at ANTEC 2012.

The budget for July 2012 was also reviewed.

Funding of IMD Scholarship

In 2006, the Board created and funded the IMD Scholarship under the SPE Foundation. After two years, the funding was temporarily deferred because the rebate receipts were suspended to assist the SPE through the economic downturn.

At this meeting, Jim proposed that since the Division's finance was in good standing, the Board could consider continuing the funding of the IMD scholarship.

IMD Board of Directors Meeting Continued

Jack Dispenza made a motion to continue funding the IMD scholarship. Discussions ensued and Kishor proposed to postpone the vote until updated information on the scholarship was obtained from the SPE Foundation.

Jon Ratzlaff asked Barbara Spain and Sarah Sullinger to coordinate getting feedback from the SPE foundation to Susan.

The motion was tabled to the Winter meeting.

Action Item1: *Susan to obtain information from Barbara Spain or Sarah Sullinger.*
Action Item2: *Susan to add this item in the next meeting agenda.*

Pinnacle Award – Erik Foltz

The new form for the Pinnacle Award was recently made available. Goals and objectives are due at the end of September. Erik will work with Susan to receive transitioned information to compile for the Pinnacle Award.

Technical Director Report – Peter Grelle

China Conference

Over the last few years, SPE HQ had been working on expanding conferences overseas. Jon Ratzlaff has made efforts in organizing a conference in China. At this meeting, Jon presented the SPE concept of putting on a conference in China, targeting the second half of 2013. Jon encouraged the IMD to participate.

In discussions, Nick Fountas commented that the IMD membership data showed that the number of IMD members in Asia was relatively small, and should be considered in the planning discussions..

ANTEC 2013

Paper reviewers for the ANTEC 2013 IMD program consist of Pat Gorton (2013 ANTEC TPC), Adam Kramschuster (TPC 2014). Erik Foltz (TPC 2012) and Peter Grelle (Director). The review meeting will be scheduled in early November.

Webinar Series

Pete had some discussions with Barbara Spain about organizing a webinar series on injection molding. He solicited input from the Board, and Brad Johnson proposed to partner with Penn State-Erie to develop the topic on '*Troubleshooting*'.

The call for suggestions posted in the newsletter received no response. Nick suggested conducting a survey to gauge topical interests from the IMD members. The taskforce for this effort consists of Peter Grelle, Jeremy Dworshak, and Erik Foltz. Other Board members who would like to participate could contact Pete.

Injection Molding TOPCON

The status for the TOPCON remained unchanged, with none planned for this year. Pete has been focusing efforts on the webinar series. Brad mentioned that he could re-organize the Penn State Injection Molding workshop into a TOPCON for Summer 2013.

Action Item 1: *Nick and Pete to work on the member survey.*

Councilor Report – Brad Johnson, Councilor

Preparation for ANTEC Mumbai is underway. Email blast has been released.

IMD Board of Directors Meeting Continued

The next Council meeting will be held in Detroit, on September 14 and 15. Brad will attend.

SPE Membership Committee – Jack Dispenza

Jack updated the Board on the activities of the SPE Membership Committee. Their focus was on student and young professional members, areas where the Society had not been very successful, and expansion into new regions or markets, such as Composites show and Rubber show.

Some student sections had been in provisional status. Jack asked Board members who have been involved with or live near universities to reach out and help these student sections.

To attract young members, the Committee was conceptualizing a design competition. Jack proposed that the IMD became a sponsor.

Other means of reaching out to students and young professionals include publishing value proposition testimonials, using social network, partnering with university professors and advisors, providing information to university periodicals, etc.

Jack proposed to add a 'Student Column' in the IMD newsletter.

Action Item 1: *Jack to provide Heidi Jensen with information for the 'Student Column'.*

IMD Membership Committee – Nick Fountas, Chair

Nick collected the membership data and presented the trends on basic demographics, young professionals, gender, and retention.

These trends will affect how the Division attracts young professionals and locations of TOPCONs. The break-down of locations where the IMD members are concentrated would be helpful.

Susan called on the Board to support efforts to get lapsed members back and to gain new members.

Action Item 1: *Nick to review the data and provide information on the geographical concentration of IMD members.*

Action Item 2: *Nick to include questionnaire on lapsed members in the members survey.*

Education Committee – Pat Gorton, Chair

No new updates.

ANTEC 2013 Technical Program Committee – Pat Gorton, Chair

Pat gave an update on ANTEC 2013. The conference will be held on April 12 through 14 in Cincinnati. The paper submission deadline is October 23, 2012. Although student papers are required to meet the deadline, extension can be made on a case by case basis.

The Society TPC for the next ANTEC has been identified and awaits approval from the Executive Committee. SPI will co-locate with ANTEC for the next three years starting with next year in Cincinnati.

For the IMD technical program, the reviewers meeting is tentatively on November 5, either in Madison, WI or Orlando, FL. The reviews are due back to SPE HQ on November 13.

Pat had discussions with SPE about including tutorial sessions at ANTEC. This program will need technical contributions from large divisions, such as the IMD. The presentation will follow the tutorial format and possibly have expert panels. Pat already identified some speakers. Barbara Spain will send an email blast before ANTEC to promote these sessions. Pat asked and obtained the Board's agreement to proceed with this plan.

IMD Board of Directors Meeting Continued

Communications Committee Report – Adam Kramschuster

The Committeee had been looking into ways to start up the Division website. Adam had pre-meeting discussions with Susan on having the website designed for a reasonable fee. He updated the Board on how the website could be developed using Wordpress, and showed some examples.

Adam brought the idea of adding 'infomercial' as a new format to the sponsorship. The 'infomercial' will be an article about one page long. The Board discussed this idea and asked for more research to be done on the impact of this format on the non-profit status of the Division.

Adam reminded everyone that the deadline for submissions for the next newsletter was October 1.

Motion: *Rick Pugkelli moved that the Board approved spending $500 to build the Division website. Pete seconded the motion and it carried.*

Action Item 1: *Adam and Heidi to investigate the effect of infomercials on the non-profit status of the Division.*

Corporate Sponsorship – David Kusuma

At the previous meeting, David suggested that the Board explore corporate sponsorship as a means to grow the Division's outward reach through projects and support. At this meeting, David presented his proposal on the action plan, which chartered three potential funding sources, namely corporations, government and product offerings (designer toolkit).

David recommended that the Board reached out to corporations as the immediate action plan. Jim, Susan and Hoa will work with David.

Action Item 1: *David to organize the first meeting with Susan, Jim and Hoa to initiate the corporate sponsorship program.*

Nomination Committee – Hoa Pham, Chair

No new updates. Hoa will ask the Board for bios later in the year to prepare for the next ballot.

Honored Service Member & Fellows – Larry Schmidt, Chair

Mal Murthy is the HSM candidate. The Division has no candidate for Fellows at this time. Larry asked that the Board let him know of potential candidates.

Old Business

None discussed.

New Business

Ram Thanumoorthy thanked the Board for inviting him to this meeting.

Jeremy Dworshak commented that the opportunity to preview trainers was valuable. The preview allowed him to gain some insights about the trainers, which could be helpful for future training decisions. He suggested that every year we invite trainers to present to the Board, perhaps at ANTEC when trainers and many Board members are present.

Srikanth Pilla thanked the Board for his appointment and expressed willingness to contribute.

IMD Board of Directors Meeting Continued

Nick Fountas asked Srikanth and Rick to provide a picture and a short bio. Nick will write a brief article to introduce the new members in the next newsletter.

Action item 1*: Srikanth and Rick provide Nick with a headshot photo and a short bio*
Action item 2*: Nick to provide member article to Heidi for the Fall newsletter.*

Next Meeting

The next Board meeting is planned to be at the Tupperware HQ Facility in Orlando, FL. Susan will confirm either January 25 or February 1, 2013.

Adjournment

Motion: Jim Wenskus made a motion to adjourn the meeting. Brad Johnson seconded and the motion c arried.
The meeting was adjourned at 3:12pm ET.

Submitted by Hoa Pham
September 6, 2012

Meet IMD's Newest Board Members

The Injection Molding Division Board of Directors, led by Chair Susan Montgomery, are pleased to welcome two new board members—Rick Puglielli and Srikanth Pilla—appointed to initial terms ending at ANTEC 2013, at which time they will seek formal election to the posts through the annual balloting of the IMD membership at large. Please join us in welcoming them.

Rick Puglielli, Promold Plastics

Rick Puglielli is the President of Promold Plastics (Portland, CT) and has been working in injection molding for the medical device industry for more than 25 years. He holds a Mechanical Engineering degree from the University of New Haven and has an extensive background in injection mold tooling, processing, and quality systems.

Notably, Rick was intimately involved in the implementation and maintenance of quality management systems registered to the ISO 9001 Standard and ISO 13485 Standard for Medical Devices. In 2008, he also completed the plant design and lean workflow layout for his company's modern world class manufacturing facility in which he organized a seamless transition of all equipment and personnel into the new 40,000 sq. ft. facility. In 2007, Promold was recognized by plasticstoday.com as one of the Top 25 Notable Processors. In 2000, Rick was named one of Hartford Business Journal's "40 under 40" business leaders.

Srikanth Pilla, Wisconsin Institute for Discovery

Dr. Srikanth Pilla is currently Assistant Manager of the Bionates Theme at the Wisconsin Institute for Discovery (Madison, WI), which he joined in part, to support the efforts of another IMD Board Member, Prof. Tom Turng, in establishing a state-of-the-art research group and facility dedicated to tissue engineering research.

Srikanth has a strong background in biobased materials, microcellular plastics, and composites research, built on his BS from JNT University, MS from U. Toledo and Ph.D. from U. Wisconsin-Milwaukee, all in mechanical engineering. He also completed post-doctoral studies in biobased materials and composites at Stanford U., after which he joined a start-up company, SuGanit Biorenewables, to scale-up a patented ethanol production technology.

Srikanth has authored/edited 2 books and more than 50 scientific articles. He is the Associate Editor of SAE International's Journal of Materials and Manufacturing and also serves on the editorial board of the Journal of Renewable Polymers. He is also the Series Editor of the Polymer Science and Plastics Engineering series.

Srikanth also serves on the technical committees of "Materials, Modeling & Testing" and "Polymer and Coatings" and co-organizes the Automotive Composites SIG of the Society of Automotive Engineers World Congress.

IMD Leadership

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Webinars

Extrusion Series II - Parts 1, 2, & 3

Part 1 Presenter: Dr. Gregory Campbell
Part 2 Presenter: Dr. Mark Spalding
Part 3 Presenter: Dr. Eldridge Mount

Dec 06, 2012 11:00 am - Dec 06, 2012 12:00 pm (GMT-05:00) Eastern Time (US & Canada)

Part 1 focuses on the screw designs used in extrusion.

Extruder screws used for continuous product manufacture are designed to provide a desired flow rate at a specific product temperature. Other requirements, such as venting and mixing are often placed on the extruder screw, resulting in a variety of available screws. Add in the variation on the configuration of the screws, as well as twin screws, and the variety is multplied. This report will summarize some of the different screws available.

Part 2 of this series will first show how to evaluate an existing screw design and determine the maximum output available.

We will then focus on how to specify the increase in extruder output and what technology to use. In addition, we'll determine the capability of the drive needed as well as how to increase the capacity needed for higher output. We will also discuss how to estimate the increase in head pressure from the down stream equipment, determining if a need exists to modify the die and melt piping.

Part 3 will focus on reviewing the prudent safety concerns associated with single-screw extrusion systems.

Eldridge began his career in Plastics in the summer of 1970, at General Electric, as a summer engineer working with Epoxy/glass filament winding. He worked two years as a synthetic Chemist for Sterling Drug and then went to Rensselear Polytechnic to perform an experimental and theoretical study of the melting and extrusion behavior of solid polymers to earn his advanced degrees. From 1978 to 2000 he has worked for ICI Americas and Mobil Chemical Films Division in the area of Extrusion, Coextrusion, orientation technology and product development for biaxially oriented films. He has always developed technology solutions and products for implementation into manufacturing

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Membership Application

Society of Plastics Engineers Membership Application

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Applicant Information

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first last mi

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company/college:
job title:
address:
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city: **state:**
zip: **country:**

Phone/Fax Format: USA & Canada: (xxx) xxx-xxxx All Others: +xx(xx) x xxx xxxx

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address:
city: **state:**
zip: **country:**
Home Phone:

(✓) **Preferred Mailing Address:** ❑ **Home** ❑ **Business**

Gender: ❑ Male ❑ Female

Birth Date: (mm/dd/yyyy)

Demographics

Job Function *(choose only one)*
- ❑ Consulting
- ❑ Design
- ❑ Education (Faculty)
- ❑ Engineer
- ❑ General Management
- ❑ Manufacturing
- ❑ Marketing/Sales
- ❑ Other
- ❑ Purchasing
- ❑ Quality Control
- ❑ R & D
- ❑ Retired
- ❑ Self-Employed
- ❑ Student
- ❑ Tech Support

Materials *(choose all that apply)*
- ❑ Composites
- ❑ Film
- ❑ General Interest
- ❑ Nylon
- ❑ PET
- ❑ Foam/Thermoplastics
- ❑ Polyolefins
- ❑ Polystyrene
- ❑ TPEs
- ❑ Thermoset
- ❑ Vinyls
- ❑ No Interest

Process *(choose all that apply)*
- ❑ Blow Molding
- ❑ Compression
- ❑ Compounding
- ❑ Engineering Properties
- ❑ Extrusion
- ❑ Fabrication
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- ❑ Injection Molding
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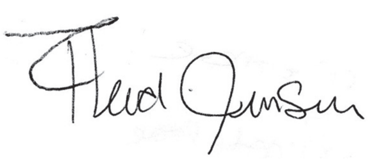
Thank you contributors!

I'd like to take a brief moment to thank the SPE members who reached out with their papers and ideas this month. It's wonderful to see such great efforts in sharing ideas, knowledge and techniques in the IMD community. I am always eager to hear from you so please do not hesitate to contact me at anytime with your ideas.

Also, if any of you have any papers for the ANTEC 2013 conference, the deadline has been extended. This is a great avenue to reach fellow Injection Molders. Send your papers to http://antec2013.abstractcentral.com.

Enjoy the holidays that will be upon us shortly and see you in the Spring!



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