THERMOSETTING February 2013

QUARTERLY NEWSLETTER ON THERMOSET TECHNOLOGY & EVENTS

www.spethermosets.org

LETTER FROM THE DIVISION **CHAIR**

Len Nunnery
Division Chair

Dear Thermoset Division Members:

It is with great anticipation that I write this note. We are two weeks away from our 2013 Topical Conference being held in New Orleans, February 26-27. Needless to say, we are getting very excited about our annual meeting and celebration!! We have 'joined forces' with the SPE Composites Division this year and look forward to networking with those members.

> "WE HAVE 'JOINED FORCES' WITH THE COMPOSITES DIVISION"

The Thermoset Division is an innovative group that is dedicated to 'getting the word out'. Our BOD members have allied together for the first time in an effort to educate regarding the subject of thermoset materials, performance, processing, part and mold design, and finishing techniques. This session will take place at the Roosevelt Hotel on February 25th (see www.spetopcon.com for a complete agenda), the day before the official conference 'kick off'. Get your important questions answered by an objective alliance of material experts ($75/person, students enter free, welcome reception to follow). Our agenda has two keynote speakers; Don Briggs, President of The Louisiana Oil and Gas Association will address the trends of the oil and gas industry as it affects the composites industry, and Gary Lownsdale, Chief Technology Officer for Plasan Carbon Composites will discuss automotive light weighting.

Jackson Square

I look forward to seeing you in Louisiana at the end of this month!

Len Nunnery
Chair, SPE Thermoset Division
Vice President, Sales and Marketing
Bulk Molding Compounds, Incorporated

OptiSpray™ Solutions

OptiSpray™ Rovings

Spray Up Just Took a Step Up

New **OptiSpray**™ rovings from Owens Corning can change the way you think about spray-up processing for demanding material applications.

- Reduced resin consumption
- Specially formulated for flat to complex molds
- Excellent processability
- Improved surface quality
- Great mechanical properties

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Based on Advantex® glass fiber, **OptiSpray**™ Solutions rovings feature the electrical and mechanical properties of traditional E-glass with the acid corrosion resistance of E-CR glass. **OptiSpray™ grade** is designed to provide optimal performance for spray-up applications where standard wet out speed is preferred in complex molds. **OptiSpray™ H grade** offers the added benefit of great lay down in large, flat molds with a consistent surface finish. And for operations that require faster wet out in complex molds or sharp curvatures, **OptiSpray™ F grade** is the perfect candidate.

New Possibilities

For applications in the marine, sanitary, swimming pool and transportation industries, **OptiSpray**™ rovings can bring advantages never before available in an open end roving. Open the door to innovation with the best-in-class performance of **OptiSpray**™ rovings from the world leader in composite solutions.

To learn more about OptiSpray™ Solutions, visit http://composites.owenscorning.com

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www.owenscorning.com

THERMOSETS FOR SOUND

AccoustaComp™ is the Answer for Speaker OEM

"THE ANSWER TO THE AUDIOPHILE'S DEMANDING WISH LIST"

The design and manufacture of high quality acoustical equipment has always been as much art as it is science. Over the decades, the loud speaker has evolved in shape, size, function and cost. The sensory requirements of the discerning listener have remained the same, however; clear, consistent sound duplication without the tinning, refraction or echoes associated with structural shortcomings. High density/high modulus AccoustaComp ™ is the answer to the audiophile's demanding wish list.

Injection and compression process friendly, AccoustaComp™ can be molded into aesthetically pleasing, complex configurations. The ideal material for satellite and sub-woofer housings and baffle frames, AccoustaComp™ is available in high gloss, molded texture and paint-ready grades. For self-powered/plug in platforms, Accoustacomp™ can be enhanced (without sacrifice to audio performance) to provide Underwriters' Laboratories yellow card recognition.

AccoustaComp™ delivers versatility and value to the art AND science of speaker design and manufacture!

Story courtesy of Bulk Molding Compounds, Inc. www.bulkmolding.com **BMCI produces AccoustaComp™ exclusively for premiere international molder, Globe Plastics (www.globecomposites.com).

ASHLAND **LAUNCHES** NEW HIGH STRENGTH FR RESIN

HETRON FR620T-29 is ideal for architectural applications

In response to the need for a versatile, high-performance fire retardant polyester resin with less volatile pricing, Ashland Performance Materials has developed Hetron FR 650T-20 resin. The new product is a low-viscosity, promoted, thixotropic polyester with exceptional fire retardant properties. Properly fabricated laminates with Hetron FR 650T-20 resin have achieved Class I flame spread rating in ASTM E-84 testing without the use of antimony synergists.

Fire retardant polyester resins have really ballooned in price over the last 18 months. Ashland recognized the need to move away from some of its traditional FR feedstocks and develop new chemistry to serve this market. According to Bruce Colley, Global FR Product Manager, "We were getting beat up pretty badly by some of our raw material suppliers. We had to pass on some very aggressive price increases which were painful for our customers to absorb. We decided to change to a better FR chemistry with more stable pricing. The result is Hetron FR 650T-20 resin with a list price that is 20% lower than previous offerings in this category."

Furthermore, Hetron FR 650T-20 resin has demonstrated mechanical properties that qualify it to be classed at a high strength resin as per the definition in Section 63.5935 of the US RPC MACT (Title 40 CFR Part 63 Subpart WWWW). Dr. Roman Loza, Research Fellow at Ashland headed up the development of the new FR resin. His assessment was as follows, "We were asked to fast track the development of a new high performance FR resin to replace products that were becoming intolerably expensive for our customers. Marketing, of course, demanded no reduction in performance. Fortunately, our team made a breakthrough that delivered not only the required FR performance but unusually high strength

> "BETTER FR CHEMISTRY WITH MORE STABLE PRICING"

mechanical properties as well - all in a resin that is formulated to only contain 35% styrene."

Hetron FR 650T-20 is ideally suited for hand lay-up, spray-up and filament winding applications. It exhibits excellent wet out properties and low drainage when applied to vertical surfaces. Its flame retardant properties make it especially attractive for use in mass transit, architectural, electrical and drainageucting applications. Field trials at multiple fabricators have confirmed its positioning. Senior Scientist, Mike Stevens, who oversaw several of these trials make the following comments, "Hetron FR 650T-20 sprays out quite nicely and wets the glass well."

Ashland intends to add Hetron FR 650T-20 resin to its Listing & Labeling program developed with the Architectural Division of ACMA and Southwest Research. This program allows fabricators to piggy back the FR testing and performance properties established by Ashland and use their label to sell into this regulated market at a fraction of the normal entry cost.

Hetron FR 650T-20 joins the portfolio of industry leading FR products offered Ashland. Where low smoke properties are required fabricators are encouraged to consider Modar 814A modified acrylic resin. Where premium corrosion resistance is required in addition to flame retardance, customers can specify Hetron FR 992 epoxy vinyl ester resin or Derakane Momentum 510C-350 epoxy vinyl ester resin. Recommendations for specific service environments can be obtained by contacting Ashland Technical Service at hetron@ashland.com.

BMCI CUSTOMER, BO-WITT PRODUCTS, **PENETRATES** MEDICAL MARKET

BMC Replaces PVC in STERIS armrail application

The market development staff at BMCI continues to investigate new opportunities in the area of clean, structural applications for medical devices. As reported in the November 2012 BMC Brief, BMC 300 recently received recognition under the ISO 10993-5 and ISO 10993-10 test protocols ('Skin Sensitization' and 'Cytotoxicity', respectively). In an effort to further illustrate the versatility associated with BMCI's custom tailored composites, the BMC Brief staff was generously granted permission by premier thermoset processor, Bo-Witt Products, Incorporated ("Bo-Witt"), to discuss one of their unique and innovative structural medical applications.

Bo-Witt customer STERIS, a manufacturer of highly versatile, premium hospital stretchers (please see www.steris.com for more complete details), approached Bo-Witt with a redesign initiative. A PVC based bed rail assembly had registered as the single largest warranty liability (due to breakage) plaguing the firm. STERIS was interested in enhancing customer satisfaction while adding value to their market leading line of Hausted Division, hydraulic stretcher products. The Bo-Witt team worked with STERIS to understand their needs and responded by suggesting rugged, clean BMC 300 as a PVC replacement composite. STERIS agreed with Bo-Witt's assessment.

The net result of Bo-Witt's expertise and understanding of the structural capabilities of BMC was a completely revamped bed rail design. The original (PVC based) assembly required seventy-two unique parts to complete. The new BMC 300 based design reduced this part count

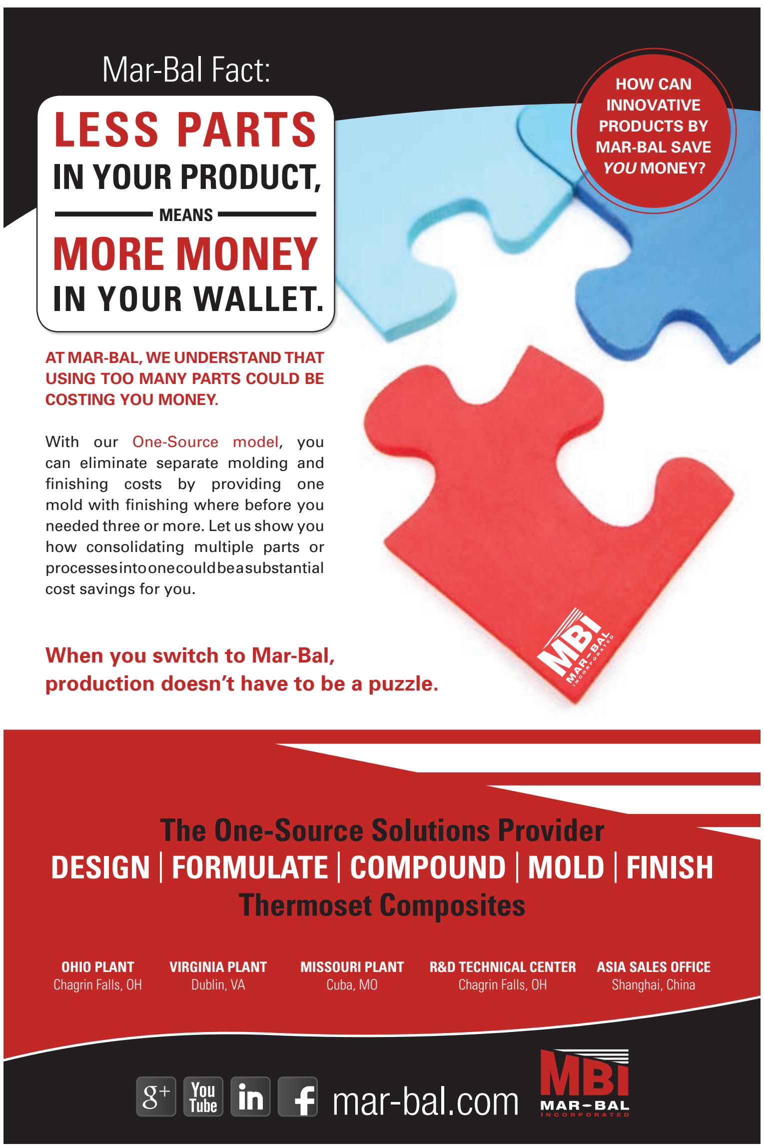
from seventy-two to only four parts!! This 94% reduction in part count led to measurable value addition for STERIS in the form of less assembly, handling, space requirements and planning. Best of all, bed rail warranty claims were eliminated by Bo-Witt's design, decreasing the costs associated with repair/replacement, while increasing customer satisfaction through enhanced product performance.

Structurally sound, aesthetically pleasing BMC can be matched to virtually any color or 'granite-look'. Additional/optional features associated with this line of products include its ability to; provide highly effective anti-microbial and stain resistant (food/human fluid) surface performance, meet FDA/USDA/ANSI/NSF cleanliness/food safety requirements and provide an extensive list of Underwriters' Laboratories test recognition, including 5-V flame ratings at 1.75mm with 160°C consistent use temperature/RTI.

BMCI would like to thank Bo-Witt Products for their innovative use of BMC in a structural medical product and for permitting this story to run in the BMC Brief. With pioneering processors/partners like Bo-Witt, the medical market is a most promising space for new, BMC supported design platforms. Please visit www.bowitt.com to review the products and services provided by this creative and talented manufacturing team.

The SPE Thermoset Division welcomes industry related news, press releases and articles regarding new technology. Please forward any material you would like considered for inclusion in our newsletter to Grapevine Marketing & Experiences: shelane@gvineme.com.

ZMC² ANNOUNCES FOUR YEAR ANNIVERSARY OF WEAR ELIMINATION



"THIS IS UNPRECEDENTED."

ZMC² 30-33HT Bulk Molding Compound (BMC), produced by Zeon Technologies of Salisbury, NC, has now been in the field for four years. When this BMC has been molded into water pump wear bushings there has been no visible or measurable wear on the bushings or the shafts which turn inside them. This is unprecedented. The combination of Zeon Resin, Kevlar fibers and ceramic beads seems to eliminate wear and operating temperatures of 200°c, are within its' scope.

The high glass transition temperature, chemical resistance, and dimensional stability at temperature have it out pacing all other wear materials including thermoplastics and metals. One pump that was returned from the field for rebuild had been abused to the point that the epoxy paint on the housing had bubbled and scorched. According to the rebuilder the only part of the pump not damaged was the ZMC² molded wear bushing and the shaft under it. Some field applications that were lasting no more than three weeks before the ZMC² BMC are now at four years and counting.

Feedback from the pump industry indicates that the Kevlar / Ceramic BMC is competitive and is the only one that works. For further information contact:

Randy Lewis
(803) 493 4173
lewispr@earthlink.net

COMPOSITE METAL TOOLING **UPDATE**

Contributed by: Randy Lewis
Edited by: Jim Cunningham

> "PROVEN TO REDUCE CYCLE TIMES AND IMPROVE PART QUALITY"

Composite Metal Tooling (CMT) is using more than one metal to achieve a synergistic effect in plastic molds. CMT is the practice of removing as much of the mass of a steel mold cavity as is practical while retaining enough for strength. The steel is removed from the area of the cavity that will not come in contact with the plastic, replacing it with a highly conductive substance. This substance is referred to as Heat Transfer Metal.

CMT has been proven in production to reduce cycle times and improve part quality. This is accomplished without giving up the advantages of hardness or toughness, which are the primary reasons for making cavities out of tool steel. The composite construction results in a cavity with the toughness and hardness of the steel combined with the greatly improved thermal conductivity provided by the Heat Transfer Metal. The resulting cavity has the properties of tool steel with a thermal conductivity approaching beryllium-copper [beryllium].

A thermoset plastic, when being molded, is converted from a solid into a plastic by the heat and pressure of the plasticizing process. With more heat and pressure the plastic cross links (cures) into a solid again in the form of the cavity into which it is forced. This creates a completely new composition of matter than the compound of materials entered the molding machine through the hopper.

Feedback from previous papers on this subject has included suggestions that the material or molding conditions could be changed to achieve the same effect. In this paper discussion is limited to what can be done to "open the processing window" by improving the thermal conductivity of the steel.

Modifying the materials or the plasticizing is for another discussion.

After any mold cavity is filled, with the specific thermoset plastic, the only factors that can influence the cure of the part are time and temperature. The heat energy to provide temperature to the molding surface of the cavity must be transferred to the molding surface from the heat source.

With the introduction of a thermoset plastic into a cavity, heat is transferred from the cavity surface to the colder plastic. This heat combined with pressure initiates the cross linking process. The mold must remain closed for the time needed to sufficiently cure the plastic until the outside of the part is strong enough to contain the forces of cross linking. Once the outside of the part is cured, the inside will continue to react and cure, even when removed from the mold. A higher mold surface-temperature causes a faster reaction and thus decreases cure time.

How fast the plastic can chemically react and cross link is one factor but returning the cavity surface to the correct temperature can be even more critical in controlling the cure time of the part. Each cycle pulls more heat out of the mold. A balance is achieved when sufficient heat can pass through the steel to maintain the correct cavity surface temperature.

Many materials are capable of curing much faster if the cavity can provide the correct temperature cycle after cycle. In this scenario the cycle time is controlled by how long it takes to transfer the heat from the heat source to the cavity surface. Unless the correct rate of heat restoration is achieved, surface temperatures will gradually decrease leading to under-cured parts and rejects or an extended cure time. The thermal conductivity of the steel and distance the surface of the cavity is separated from the heat source determine how fast the temperature recharging can occur. The rate of this recharging is a critical factor in providing a consistent and faster cycle.

Even though higher mold temperatures would provide a faster cure, the cavity surface temperature must be kept low enough to allow for complete filling of the cavity before the material returns from the plastic to the solid state. Viscosity increases as the material flows through the mold and is exposed to temperature and pressure. Molders walk a knife-edge, fighting a battle between running a thermoset mold hotter to achieve faster cycles but cool enough to fill the cavity easily. The result is usually the compromise of running a cooler mold that extends the cure time versus a hotter mold that adversely affects the filling. The delay in time beginning when a plastic extracts the heat from the cavity to the replacement heat arriving at the cavity surface is also a major difficulty. The challenge is to supply enough heat to meet the demands for curing the plastic at the desired cycle.

Significant time is required to replace the heat lost at the cavity surface. Temperature controllers with well-placed thermocouples cannot compensate for the lag time caused by the resistance of the steel to heat flow. Molders add more watts (turn up the heat) to increase the force that drives the heat through the steel. When molding is stopped, heating continues with no heat being removed by the plastic until the thermocouple reaches the temperature set on the controller. This causes the cavity surface to “override the controller” and to be hotter than desired for molding at startup. Five or ten molding cycles can be required until the correct mold surface temperature can be reached and the process is stabilized. Each cycle interruption, depending on its’ length, will require a different number of cycles to stabilize the process.

The above-mentioned problems do not occur in beryllium or aluminum molds. This is due to high coefficient of thermal conductivity. However, these materials cannot provide the strength and wear resistance of a tool steel mold. Composite Metal Tooling provides both needed characteristics.

As an example, assume a core [male side of a cavity] that produces a 6” x 6” x 3” deep box with a heat source 6” away from the 6” x 6” surface of the bottom of the box. This would assume a 2” material well and the heaters in the same block of steel one inch above the well. The material well is space left in the cavity to be filled on injection with materials that will be compression molded in the cavity.

The process and material are injection - compression molded BMC with an electrically heated mold. The standard mold temperatures of 165º C (330º F) with the plastic material injected into the mold at 54º C (130º F) would provide a ΔT of 111º C (200º F). This ΔT is about the same as when throwing ice into boiling water; the heat is sucked out of the mold like the ice sucks the heat out of the hot water. Too much ice, or too fast a cycle, and the water will stop boiling until the heat recovers by passing from the heat source, through the pan. The same is true of too fast a cycle and the heat being sucked out of the mold causing under-cure. Either the water is cooled by dropping in ice at fixed intervals, or the particular plastic being molded on a fixed cycle sucking heat from the mold both is the same. The plastic requires as exact a temperature point to maintain a consistent cycle as the water to boil.

Like boiling water in a steel pot that is six inches thick, the heat source in this mold is separated from the molding surface by steel that will only transfer about 40 w/m ºc. The heat that is transferred through the steel is removed from the cavity surface by the BMC requiring a 200º F, ΔT for quality molding. The surface temperature drops and the required temperature must be restored by heat from the electric heaters.

The faster the cycle, the faster heat is removed and the faster that replacement heat must be supplied before the next injection, if the desired cycle is to be maintained. We molders say, “The heat is sucked out of the mold”, when the demand rate for replacement heat is exceeded by the amount that can be transferred through the steel.

Only two actions are possible when the heat transfer rate is too slow in a standard steel mold, one is to slow down the cycle to match the rate that the heater system can recharge the molding surface or turn up the heat to drive more watts through the steel.

As discussed above, when more watts are used, the cycle can be faster, but because of the lag time caused by the heat passing through the steel, a mold tends to over ride the controllers. The over temperature result is non fills or other over heat related problems each start up, until the mold reaches equilibrium. Equilibrium is that balance when the correct number of watts passes through the steel equals the amount removed by the BMC. If the watts and cycle are not balanced, the process person constantly “chases his tail”.

The formula for calculating the heat transfer through a flat cavity is:

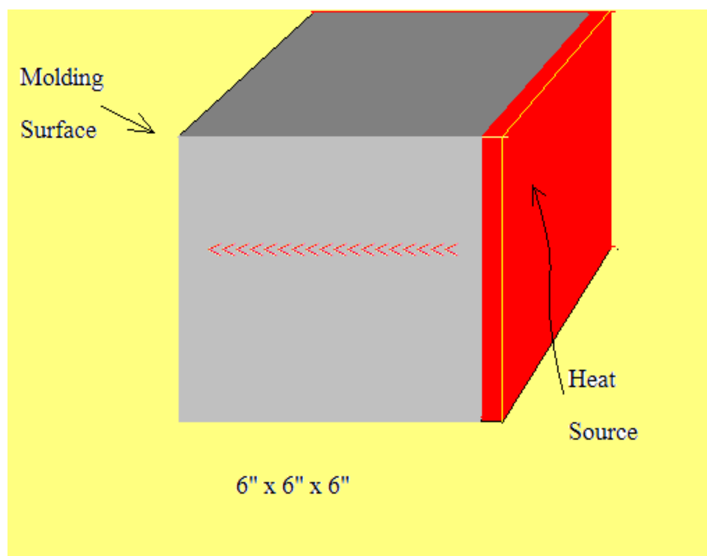
$$Q = \frac{ka(Th-Tc)\,t}{D}$$

Q	=	the amount of heat conducted
k	=	coefficient of thermal conductivity (w/m ºc)
a	=	Projected area (m^2)
Th	=	temperature of hot side (ºC)
Tc	=	temperature of cold side (ºC)
d	=	distance from hot side to cold side (m)
t	=	time (time is considered to be a one (1) sec. constant since a comparison between molds is all that is being considered.

The 6” x 6” x 6” block of steel that serves as the force will transfer 677 W/m/ºC when the ΔT of 200º F. We are using only one Δt for one second in this calculation since the purpose of the calculation is only to show the relationship between the coefficient of thermal conductivity of various cavities and cores.

Coefficient of Thermal Conductivity

k=	40 w/m/ºc
Q=	$\frac{ka(Th-Tc)t}{d}$
Q=	$\frac{(40)*(.1524*.1524)*(156-54)1}{0.1524}$
Q=	676.66 w/m/ºc

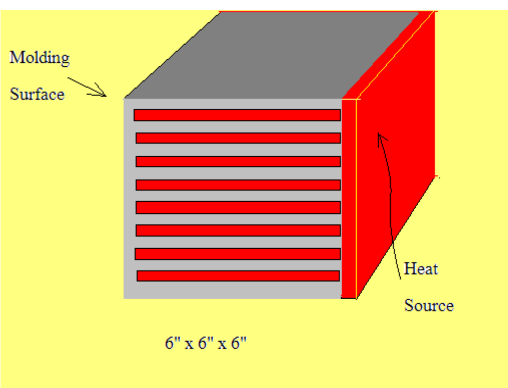


A way to reduce the temperature lag time to a manageable and controllable level is to increase the thermal conductivity of the steel cavity by making it a composite. This is accomplished in this example by drilling the back of our cavity with a seven by seven pattern or forty-nine one-half inch holes to within 0.250” of the 6” x 6” molding surface. There is also 0.250” separating each hole. By filling the holes with Heat Transfer Metal we retain the strength and wear qualities of the steel while improving thermal conductivity.

In calculating the thermal conductivity of the new cavity, subtract the thermal conductivity of the steel removed and then add that of the Heat Transfer Metal. This gives the force a thermal conductivity of 2831 W/mº/c or an increase of more than four fold.

		w/mº/c			w/mº/c	
	k=	40			390	
	Q=	ka(Th-Tc)t			ka(Th-Tc)t	
		d			D	
	Q=	(40)(156-54)1			(390)(156-54)1	
	Steel	0.14605		HTM	0.14605	
	Holes	4	w/mº/c	Rods	48	w/mºc
Q=	-49	-189		49	2343	

Steel - Holes + HTM = 2831



By contrast a beryllium force would have a CTC of 3214 W/mºc. The example core has 87% of the thermal conductivity of a solid beryllium cavity.

Case Study

Company:
Mold Maker:

Elring Klinger Sealing Systems

Service Mold, Inc.

1 Seneca Road
2711 Etienne Blvd.

Leamington, Ontario N8H 3W5

Windsor, Ontario N8W5B1

Canada

Product: BMC Valve Cover 2006 Chevrolet Trucks

Molding Process: Injection Compression

Expectations: Decreased mold heat up time and even cavity heat.

Competition: Heat Pipes

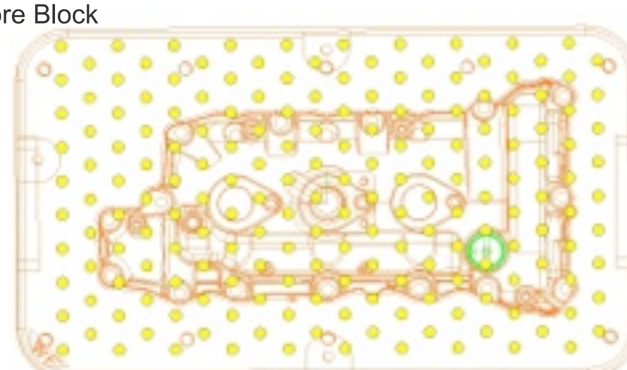
Core Block: H-13 @ 48 RC, 23” x 11.5” x 6.5” Average Height

CMT Application: Cavity was drilled, 188 ea. – ½” dia. holes, with 3/4” between holes on the non-plastic contact side of the core and the holes were filled with Heat Transfer metal.

Calculated Thermal Conductivity W CMT: 95 w/m/ºc or 2.4 times more than H-13 Approximately equal to brass at 100 w/m/ºc

The mold is being shot after the submission deadline for this paper. A report on actual results will be given at the TOPCON.

Core Block



Valve Cover Composite Mold

CASE STUDY
THERMOPLASTIC

Contributed by: Tim & Todd Bryant
Owners of StayNet Sports Systems
Kernersville, NC

One of the safety problems in kid's soccer today is the frame that holds the net. These frames are usually made from iron pipe and can weigh several hundred pounds. Deaths have been attributed to frames turning over and striking children as the frames are moved.

designed a new net system using extruded aluminum for the cross beams and connectors molded initially from 45% glass filled nylon which was increased to 65%, ¼" length, glass-filled nylon. This is an exceptionally high glass loading and glass length for injection thermoplastic. The injection molded parts fit inside the aluminum tubes to hold the net frame together. With this construction the goals are light enough to greatly lessen or even eliminate the safety concerns. The frame design called for seven nylon connectors with two deemed structurally and dimensionally critical. They were the two 90º nylon corner connectors and the one straight connector which joins the two aluminum tubes of 6' each which make up the 12' cross bar of the goal.

The 90º connector not only needed the strength to support the cross tubes but also to controls the frame alignment. A warp of 1º over 6' translates into a 1.224" misalignment. In other words, the part must be perpendicular in its' 90º bend.

Liability concerns for crucial nylon connectors and the warp requirement for the one persuaded Staynet™ to use Composite Metal Tooling.

This CMT is made up of P-20 for the cavity block with 0.500" Heat Transfer Metal rods. There is 0.100" separation between the rods which extend to within between 0.100" of the molding surface. Small diameter MoldmaxTM core pins were used for the third metal in the Composite.

The two tools were approximately $35,000.00 each. The impact of adding the CMT was an increase of $7,500 to the cost of each tool.

Results:

The tools performed as quoted and on the 90º bend is molded with literally no measurable warp. The cycle time is not a concern in this application so it was not considered. The part is being molded on an 80-second cycle hand loading 2 inserts on each cycle.

A surprise was the difference in appearance of those parts molded on the CMT as opposed to the non-CMT molds. Normally, highly glass filled nylon parts have a rough appearing surface with glass fiber showing. This was apparent in appearance of those molded on the non-CMT molds. Those parts produced with the 45% glass loading on the two CMT molds had the smooth surface of non-filled nylon. The parts were molded using:

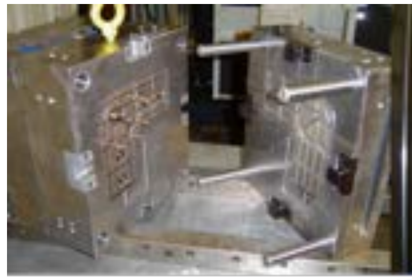
The same material

Dried in the same dryer

Shot in the same press with only shot size changed

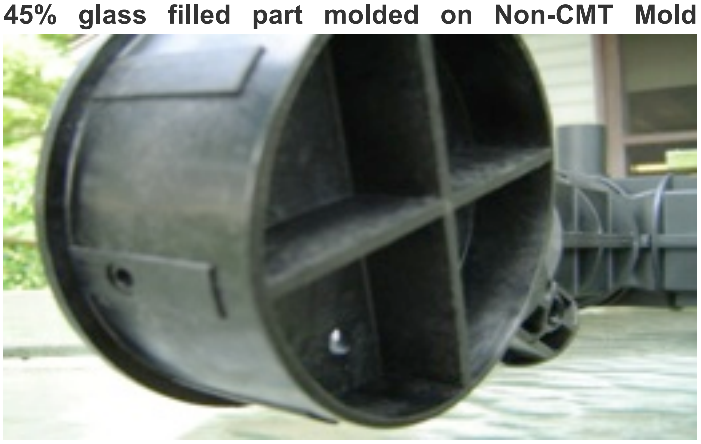
With the same mold temperature

The only difference is that the CMT molds had a much longer flow through the mold because the parts were much larger. Tim Bryant stated that this is probably the first time a nylon with this loading and glass length has been injection molded in a deep draw, thin walled part.



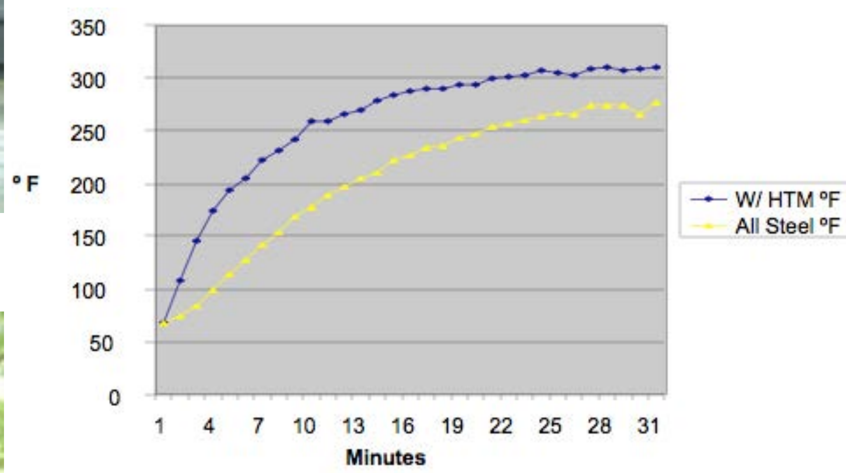
STAYNET
SPORTS SYSTEMS
Our Goal is Safety

45% glass filled part molded on Non-CMT Mold



45% glass filled part molded on Non-CMT Mold

Heat Curve CMT Mold vs. All Steel Mold



Heat Transfer Measurements Staynet™ CMT Mold Section VS all Steel Mold.

Temp Test				Heat Source		340	375	
				Avg	358	ºF		
Time	W/ HTM	Rise	ΔT	W/0 HTM	Rise	ΔT		ΔT
Min	ºF	per Min	Heat Source	ºF	Per Min	Heat Source		W / CMT (-) W/ O
0	68		290	68		290		
1	108	40	250	74	6	284		34
2	146	38	212	84	10	274		28
3	174	28	184	99	15	259		13
4	194	20	164	114	15	244		5
5	205	11	153	128	14	230		-3
6	222	17	136	142	14	216		3
7	231	9	127	154	12	204		-3
8	242	11	116	169	15	189		-4
9	259	17	99	178	9	180		8
10	259	0	99	189	11	169		-11
11	266	7	92	197	8	161		-1
12	270	4	88	205	8	153		-4
13	279	9	79	210	5	148		4
14	284	5	74	222	12	136		-7
15	288	4	70	227	5	131		-1
16	290	2	68	234	7	124		-5
17	290	0	68	236	2	122		-2
18	294	4	64	243	7	115		-3
19	294	0	64	247	4	111		-4
20	300	6	58	254	7	104		-1
21	301	1	57	257	3	101		-2
22	303	2	55	260	3	98		-1
23	307	4	51	264	4	94		0
24	305	-2	53	267	3	91		-5
25	303	-2	55	266	-1	92		-1
26	309	6	49	274	8	84		-2
27	310	1	48	274	0	84		1
28	307	-3	51	274	0	84		-3
29	309	2	49	266	-8	92		10
30	310	1	48	277	11	81		-10

Full Page, 8.75 x 11.25 bleed, 8.5 x 11 trim, 7.5 x 10 live