New Shore 60D Urethane For High Wear Foundry Applications

INTRODUCTION

PTM&W Industries has developed a new castable Shore 60 D durometer urethane that offers real advantages for the foundry industry. The product, PT7665 A / B, when compared with conventional 60 D urethanes, urethane board stock and aluminum plate, can offer longer pattern life and overall cost reductions.

What makes this urethane system unique is that it can be mass-cast without the short working times, high exothermic reactions, and shrinkage associated with conventional Shore 60 D urethanes.

DISCUSSION

It has long been known that Shore 60 D urethanes offer advantages over traditional foundry pattern materials. Excellent wear resistance and toughness have been the primary reasons shops have increasingly switched to urethanes. This paper documents the increased abrasion-wear resistance obtainable with Shore 60 D urethanes.

With the development of PT7665 A / B (containing Poly-Cure 1000, a PTM&W Industries proprietary hardener) many of the objections to using conventional Shore 60 D urethanes, i.e., short working times and excessive shrinkage, have been overcome.

Abrasion-Wear Advantages

Abrasion-wear resistance of foundry patterns is directly related to production tool life. With the advent of CAD and NC machining, an increasing percentage of patterns are being machined, either from urethane board-stock or aluminum (either cast or plate). Urethane board-stock works fine for prototypes and in short-run production, but quickly deteriorates when subjected to sand abrasion during longer production runs. Where longer pattern life is required, most shops will turn to cast or machined aluminum as the material of choice. Very high production rate patterns are usually made of tool steel.

It was decided to conduct abrasion-wear studies comparing PT7665 A / B to two commonly used foundry pattern materials; urethane board-stock and aluminum plate. There are a wide variety of board-stock brands and aluminum alloys from which to choose. Our selections are those with which most shops will be familiar.

A six-station Wheelabrator grit-blasting machine was made available for our testing by Edelbrock Industries of Torrance, CA. Cast blocks of PT7665 A / B were run side-by-side with machined urethane board-stock blocks and a machined aluminum block to generate wear comparisons based upon weight loss. It can be debated that the Wheelabrator test is harsher than what a typical pattern would see in service. While that may be true, the results we have obtained are for comparison purposes only. We believe the tests give an indication of comparative tool life.

PT7665 A/B Vs. Urethane Board-Stock

Tool Chemical Company (TCC) 1052 "Red Board" and Vantico 5168 (green) urethane board-stock were chosen for testing because they are widely used in the foundry pattern industry for making prototype and short-run patterns. Both of these materials and PT7665 A / B were machined into 4-inch cubes.

Fig. 1
Three Urethane Cubes Ready to Be Tested on Wheelabrator Grit-Blast Machine

All three cubes were subjected to a total of 30 hours in a Wheelabrator grit-blast machine. (Fig. 1) The blasting media used was Amasteel SG-40 grit. During the 30 hours total machine time, the blocks were under direct exposure to the high intensity blasting for a total of 8 hours.

TABLE 1 - ABRASION WEAR STUDY
30-Hours Exposure To Wheelabrator Grit-Blast Machine

	PTM&W PT7665 A/B	Tool Chemical 1052 Red-Board	Vantico 5167 (Green)
Initial Weight	1221.1 gms.	1317.7 gms.	1227.8 gms.
Wt. After Test	1189.9 gms.	1008.4 gms.	973.4 gms.
Weight Loss	31.2 gms.	309.3 gms.	254.4 gms.
% Weight Loss	2.56 %	23.47 %	20.72 %

Table 1 shows the before and after weights of each block and the associated percentage weight loss. As shown, PT7665 A / B lost 2.6% of its weight, TCC PT1052 lost 23.5% and Vantico 5168 lost 20.7%. Because the densities of all three materials are extremely close, we can conclude that the percentage loss in weight is the same as the percentage loss in volume, due to wear.

In addition, the edges and corners of both urethane board-stock blocks were severely rounded and worn, whereas the PT7665 A / B block still had sharp edges and corners. (Fig. 2) The six flat surfaces of each board-stock block were pitted. The PT7665 A / B block was still smooth.

Fig. 2
Three Cubes After Wheelabrator Grit-Blast Test

The result of this test indicates that PT7665 A / B pattern should outlast a typical urethane board-stock pattern by ten times or more.

In addition to vastly increasing tool life, using PT7665 A / B urethane as a pattern saves costs by lessening machine down time due to replacing working patterns. Also, crisper, cleaner castings will be produced from patterns which have not lost their definition due to wear.

PT7665 A/B Vs. Aluminum Plate

Once it was determined that PT7665 A / B had much better abrasion-wear resistance than urethane board-stock, we decided to test it against aluminum. Cast aluminum is often used for patterns but due to its porosity, does not wear as well as tooling plate, such as MIC-6.

Fig. 3
Aluminum and Urethane Cubes Ready to Be Tested on Wheelabrator Grit-Blast Machine

A cube of each of MIC-6 aluminum tooling plate and PT7665 A / B cast urethane was exposed to 80 hours in a Wheelabrator shot-blast machine using Amasteel SG-40 grit. (Fig.3) Of that 80 hours machine time, there were approximately 21 hours of direct exposure to the high-intensity blast. Table 2 shows before and after weights, percent weight loss and volume lost (after adjustment for density).

TABLE 2 - ABRASION WEAR STUDY
80-Hours Exposure To Wheelabrator Grit-Blast Machine

	PTM&W PT7665 A/B	MIC-6 Aluminum Tooling Plate
Initial Weight	549.2 gms	1159.5 gms
Weight After Test	531.6 gms	1094.2 gms
Weight Loss	17.6 v	67.1 gms
% Weight Loss	3.2 %	5.79 %
Volume Lost*	16.1 cc	25.4 cc

*Note: Density of PT7665 A/B = 1.09 gms/cc
Density of MIC-6 Tooling Plate = 2.56 gms/cc

As shown, PT7665 A / B wears 1.58 times, or 50% better, than MIC-6 tooling plate on a basis of the volume of material lost. Visually, the aluminum showed much more evidence of wear than the urethane. The aluminum had a pebble-grain surface texture and rounded corners and edges. (Fig. 4) The PT7665 A / B surfaces remained smooth with sharp corners and edges.

Fig. 4
Aluminum and Urethane Cubes After Wheelabrator Grit-Blast Test

This test indicates that PT7665 A / B should outwear machined MIC-6 tooling plate patterns by 50%. It should outwear cast aluminum patterns by an estimated 2-3 times.

Impact Resistance Advantages

Abrasion-wear resistance is not the only factor that determines foundry pattern production life. Often patterns are damaged during transportation to and from the pressing area or while the pattern is being mounted or dismounted to the machine. Urethane board-stock, being usually Shore 80-85 D hardness, tends to be brittle. Any impact can chip or fracture corners and edges. Aluminum is tougher than board stock, but can still be damaged if a corner or edge is struck.

PT7665 A / B is an extremely tough material. This urethane is used in the aerospace industry for facing drop-hammer dies for metal forming. It is cast into blankets for use in hydro-forming machines. It can literally be hit with a sledge-hammer without damage. Patterns made with this material are impervious to damage associated with foundries.

Machining Advantages

If large patterns are cast to near-net shape (see 2.5.2.2) they must be machined to final contour. Although technically being an elastomer, PT7665 A / B machines beautifully (Fig. 5a). No actual side-by-side empirical machining tests were done. But, the observation of an experienced machinist was that the Shore 60 D urethane machined twice as fast as aluminum tooling plate. This was done with standard cutters. Special cutter geometries, made for cutting plastic, may add to the speed. Figure 5b shows the surface quality obtainable by machining.

Fig. 5 a & b
Machining PTM&W Urethane

Mass Casting Advantages

Shore 60 D durometer urethanes have been used for many years in the foundry industry for surface casting thin faces on patterns. Products such as Vantico RP6444, Hapco 664 and PTM&W PT7660 A / B are commonly used because of their high abrasion-wear resistance. The drawbacks with these systems are they all have short working times and tend to be exothermic during cure. What makes PT7665 A / B unique in the market is that it is made with a proprietary hardener called Poly-Cure 1000. This product has 100 minutes of working time before it gels and, as a result, generates very low exothermic temperatures.

The traditional Shore 60 D urethanes have short working times (typically 20-30 minutes). If the surface cast is over a large area, it is difficult to have sufficient time for the material to completely fill the cast without leaving voids and / or knit lines. It is often necessary to make multiple pours at different points of the casting to get a complete fill. PT7665 A / B allows a lot more working time. The mixed viscosity builds very slowly, which allows plenty of time for the material to flow over large areas before gelling.

When traditional Shore 60 D systems are cast too thick (usually over 3 / 8-inch), the exothermic heat that is generated can cause surface distortions, pocket shrinkage and out of tolerance dimensions due to linear shrinkage. The PT7665 A / B system, with its low exotherm, can be cast up to 6-inches thick without surface deformations or significant linear shrinkage.

Urethane Pattern Applications

The versatility of PT7665 A / B offers advantages when making either small or large patterns

Small Patterns

The technology associated with PT7665 A / B allows small and medium sized patterns to be cast solid without having to core them out. (Fig.6) Traditional Shore 60 D urethanes require the surface cast to be held to a maximum of 3 / 8-inches thick. While you spend more in material costs when casting a solid urethane pattern, it is more than offset by the cost of labor in making and rigging up a core for surface casting.

Fig. 6
Small Pattern Cast Solid

Large Patterns

There are three ways to make large patterns which take advantage of the qualities of PT7665 A / B, i.e., long working time, low exotherm, and excellent machining.

Casting Solid

Large patterns can be cast solid up to 6-inches thick with PT7665 A / B. (Fig.7) Thicker castings can be made if some shrinkage can be tolerated when the pattern shape is going to be subsequently machined. This method is expensive in material costs, however, labor is often the biggest expense in making a large pattern, and this method removes a lot of the labor. You simply mass-cast the material to a finished contour or mass-cast it and machine the final shape.

Fig. 7
Larger Casting, Cast Solid

Casting Near-Net Shape

Casting a large pattern to near-net shape trades increased labor costs for lower material costs. A core can be made from various materials; wood, light-weight epoxy back-fill, or urethane foam. (Fig.8) The core is then rough machined to about ½-inch under the finished contour. A rough reverse shape is then made, allowing for a 1-inch (or more) stand-off. The PT7665 A / B is then cast into the stand-off area and allowed to bond to the core and release from the rough reverse shape. Once the urethane has cured, it is N / C machined to the final pattern contour.

Fig. 8 Urethane Cast to Near-Net Shape(without core), then machined.

Surface Casting

The process for large patterns that uses the least amount of material but uses the most labor is surface casting. (Fig.9) A core is rough machined to about ½-inch undersize. A reverse shape is then fabricated or machined to the exact finished contour of the pattern. PT7665 A / B is then cast into the ½-inch stand-off area and allowed to bond to the core and be released from the reverse. After curing, you can demold the ready-to-use pattern. PT7665 A / B will allow sufficient time and flow characteristics to fill large surface casts.

Fig. 9
Urethane Surface Cast
over Metal Core

CONCLUSIONS

A new Shore 60 D urethane system can significantly increase pattern life in applications where abrasive-wear, due to sand, is a problem. PT7665 A / B will out wear urethane-based machinable board-stock by ten times. Compared to patterns machined from MIC-6 aluminum tooling plate, this system will outwear the aluminum by at least 50%.

PT7665 A / B is unlike any other Shore 60 D urethane system on the market. It allows patterns to be mass-cast in thickness not possible before, due to its long working time and low exotherm. Normal problems like surface deformation and high linear shrinkage are minimal when patterns up to 6-inches thick are cast.

The versatility, high abrasion-wear resistance and excellent machinability of this urethane system offer cost savings and new ways of making small and large patterns.

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