A ONE-SHIFT SHELL: SPEED UP THE SHELL ROOM FOR PROFIT

By Tom Branscomb
Director of Technology, Buntrock Industries

Abstract

Cycle time reduction has direct impact on profitability for several reasons. Quick response and delivery also makes it possible to get on the "Other" customer list: ***Most Improved Supplier.*** A unique shell system is presented that can take a part from assembly Monday morning, apply 6 coats in one shift, dewax the next morning, and have a metal casting by noon on Tuesday. The only special equipment needed is a low humidity final dry cabinet. A slurry consisting of a 35% silica sol and a fiber enhanced dry blend of fused silica powder was found to be able to meet the requirement of wax to metal in less than two days. Using super absorbant polymer coated stucco techniques pioneered by the University of Birmingham (UK), this cycle time can be reduced to less than one day, but the shell may not be a robust.

Introduction

In today's business climate, speed of manufacturing is important for many reasons. Customers expect and demand short times from order placement to order delivery. Some of the many advantages for the manufacturer, besides satisfying the customer, are:

- Ability to increase through put without additional factory space
- Lower inventory in process
- Reduced time span needed to ship parts
- Shorter development times
- Lower scrap rates should a problem occur (less product at risk)

One of the opportunities for reducing span time for investment casting is in the shell room. Typically, investment casting shell rooms take 2-4 days to shell parts. Very little of this time is direct labor. Most of this time is needed for drying between dips and final drying before dewax.

Buntrock Industries looked at several shell systems and binders to develop a shell that would reduce the shelling time to only one day from wax assembly to dewax. One customer had asked that dipping would occur on day shift only. So, this challenge was to receive the wax or rapid prototype pattern Monday morning, have it completely shelled by the end of day shift, dewax Tuesday morning, and pour metal Tuesday afternoon.stabilized Alpha and Beta phases of Titanium. The Oxygen content in the surface layer is much higher than in the base metal. This layer is hard and brittle compared to the base metal and must be removed from many castings, especially those that have critical mechanical property requirements. Alpha case can be removed by machining, blasting, and chemical milling.

Experimental Procedure Using Standard Stucco

Several shell systems were tested and the one with the best overall shell strengths was the following:

Binder – Buntrock Industries TMM35 (35% SiO_2) + 10% polymer.
Flour - Buntrock Industries Fibercoat 229 (fiber enhanced fused silica blend)

Wax bars (8" x 1.25" x 0.25") were dipped to determine shell MOR properties. The dip sequence was as follows:

Dip	Slurry	Stucco	Time	Dry Time (Hrs)
1	Zircon/ fused silica	80x100 FS	0800	1
2	Fibercoat 229	50x100 FS	0900	1.5
3	Fibercoat 229	30x50 FS	1030	1.5
4	Fibercoat 229	30x50 FS	1200	1.5
5	Fibercoat 229	30x50 FS	1330	1.5
6	Fibercoat 229	None (seal coat)	1500	1.5

Drying of these dips was done at 40% RH using a fan. Final Dry was in a desiccator (<10% RH) for 16 hours.

An even faster shelling time is possible. Buntrock Industries has worked with University of Birmingham (UK) using super absorbent organic polymer coated stucco. This stucco works well with a standard small particle sol and fused silica flour. Both interdip and final drying was done at 30% RH with a fan. MOR bars were broken at the end of the 4-hour final dry.

Dip	Slurry	Stucco	Time	Dry Time (Minutes)
1	Zircon/fused silica	80x100 FS	0800	60
2	Fused Silica	50x100 FS	0900	60
3	Fused Silica	30x50 FS SAP Coated	1000	5
4	Fused Silica	30x50 FS SAP Coated	1005	5
5	Fused Silica	30x50 FS SAP Coated	1010	5
6	Fused Silica	None (seal coat)	1015	5
7	Fused Silica	None (seal coat)	1020	240 (4 hrs.)

Results of MOR Testing:

MOR Test (2" Span)	TMM35 Fiber-coat 229 30x50 FS	Nyacol 830 Fused Silica SAP Coated Stucco
Green MOR (psi)	669	302
Thickness (in.)	0.312	0.241
Break Load (lbs.)	27	7
Hot/Wet MOR	274	221
Break Load (lbs.)	11	5
Warm (500C-5 min) MOR	890	744
Break Load (lbs.)	36	17
Hot (982C - 2hrs.) MOR	1262	1012
Break Load (lbs.)	52	25
Fired MOR	382	240
Break Load (lbs.)	16	5

Discussion

The green MOR is low for the coated stucco MOR bars as is the thickness, so the breaking load is very low. I usually look for about 10 lbs. breaking load to indicate adequate green strength (handling issues). The hot/wet MOR values are adequate for the high silica binder shell, but quite low for the SAP coated stucco shell. Since the coated stucco shell was thinner, this indicates that difficulty may be encountered with autoclave dewaxing. The Warm MOR values are very good for both systems indicating that flash fire dewax would be the preferred method of dewax for both systems. Additional dips may be needed for parts using coated stucco to get enough bulk shell to increase the warm breaking load enough to withstand autoclave pressures.

Hot and Fired MOR's are fine in both systems. I prefer to see loads of 20 lbs. or greater.

Both of the above systems have successfully produced small molds through dewax in our lab. See Figures 1 and 2. The coated stucco method is the faster of the two, but the MOR numbers favor the fiber enhanced, high binder silica

system. More dips using coated stucco could improve the Hot/Wet and Warm MOR breaking loads and this would only take 5 or 10 more minutes of dipping time.

Both systems need to have further development work, especially with more difficult shapes.

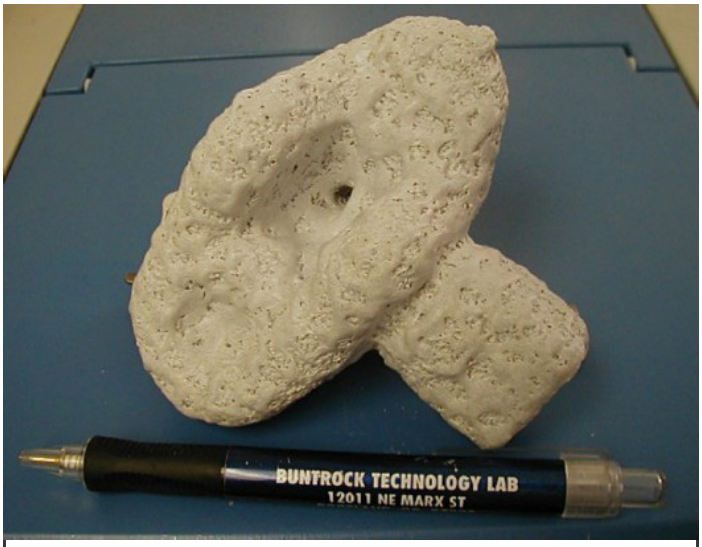

Figure 1. Dewaxed Part – One Day Shell

Figure 2. Dewaxed Part – Coated Stucco One Shift Shell.

Conclusion

Both super absorbent polymer coated stucco and reduced water binders show promise for producing production shells in very short times. Further field development work is needed and the actual dry time needed is probably dependent greatly on the part configuration.

Acknowledgments

Special thanks is given to Greg Czajka of Aristocast, Inc. for providing wax patterns for this paper.

Also recognition is given to Dr. Samantha Jones of the University of Birmingham (UK) for assistance with the polymer coated stucco technology.

LEARN MORE AT
WWW.BUNTROCKINDUSTRIES.COM

Contact Buntrock Industries:

1170 Jamestown Road,Williamsburg, VA 23185

737.233.2090 | 800.537.6482 | sales@buntrockindustries.com