Additives Impact Shell Properties

Matrixcote® System with Fibers & Polymers Positively Impact Shell Properties

When added to colloidal silica-based backup slurries, the concentrates in the Matrixcote system have been proven to positively enhance shell properties. These highly adaptable, user-friendly slurries can be used in a variety of combinations, containing varying levels of surfactants, fibers and/or polymers. Shells made from the concentrates in the Matrixcote system provide best-in-class performance when compared to standard backup slurry systems.

Background

Historically, the binders used in ceramic shell production have been either alcohol-based ethyl silicate, water-based colloidal silica or a hybrid of these. Refractories, for the most part, are fairly standard and consist of zircon, fused silica or aluminosilicates.

The evolution of technology has mainly been in the binder field where complete binders and binder additives are available to improve the casting product and/or process.

- Adopting technology in primary slurries is often an easy decision as there are very few primary coats in a shell and the impact on casting quality is immediately evident.
- Adopting new technology for backup slurries and shell coats is often more problematic as these layers make up the bulk of the shell and added material costs increase with additional coats applied. However, technology can provide both process and economic benefits if applied to backup coats.

The laboratory work and analysis in this case study examined a variety of new technologies involving the use of fibers and polymers in a backup shell system.

Laboratory Testing

In an effort to examine the impact of the addition of fibers and polymers on shell properties in a backup shell system, R&R conducted this case study using the Matrixcote system. A total of nine backup slurries were built for this study. The Control slurry was a standard, non-fiber, non-polymer, backup slurry. The remaining slurries were built using the Matrixcote system, each with varying levels of fibers and polymers. Neither percent refractory nor viscosity were held constant for this study. All systems were tested at normal operating conditions. Slurry specifics are shown below.

Sample ID	Refractory %	Viscosity (Zahn 5)
Control (No Polymer, No Fiber)	65.9	13.7
P1 (Normal Polymer, No Fiber)	67.5	11.0
P1F1 (Normal Polymer, Low Fiber)	68.4	14.5
P1F2 (Normal Polymer, High Fiber)	68.4	17.5
P2 (High Polymer, No Fiber)	65.7	11.5
P2F1 (High Polymer, Low Fiber)	66.8	12.0
P2F2 (High Polymer, High Fiber)	65.1	17.0
F1 (No Polymer, Low Fiber)	65.1	11.0

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Results

Shell properties, including Modulus of Rupture (MOR), Adjusted Fracture Load (AFL), deflection and thickness were analyzed at various testing conditions, including green (unfired) and post fired. Normalized results are shown below.

	Control *No Polymer, No Fiber*	**P1** *Normal Polymer, No Fiber*	**P1F1** *Normal Polymer, Low Fiber*	**P1F2** *Normal Polymer, High Fiber*	**P2** *High Polymer, No Fiber*	**P2F1** *High Polymer, Low Fiber*	**P2F2** *High Polymer, High Fiber*	**F1** *No Polymer, Low Fiber*
Green								
MOR, psi	1.00	2.62	2.28	2.55	3.39	2.87	2.57	0.97
AFL, lb.	1.00	2.29	2.64	3.31	2.58	2.66	2.76	1.20
Deflection, mm	1.00	2.25	1.88	1.94	3.13	2.13	2.38	1.00
Thickness, mm	1.00	0.93	1.085	1.14	0.87	0.96	1.03	1.11
Post Fired								
MOR, psi	1.00	0.81	0.84	0.79	0.75	0.97	0.85	0.95
AFL, lb.	1.00	0.67	0.97	1.06	0.55	0.79	0.91	1.17
Deflection, mm	1.00	0.88	0.92	0.80	0.88	0.92	0.80	1.08
Thickness, mm	1.00	0.91	1.07	1.16	0.85	0.90	1.04	1.11

As is evident from the above results, the addition of fibers and polymers used in the Matrixcote system slurries positively impacted the shell properties.

Fibers (F#)

- Increased shell thickness.

Polymers (P#)

- Increased green strength and green deflection (elasticity) of the shell to reduce shell cracking during dewax.
- Decreased post fired shell strength to aid in shell removal.

Fibers & Polymers (P#F#)

- Offered potential for coat reduction due to increased shell strength and thickness per coat.

3535 Briarfield Boulevard | Maumee, OH 43537 USA
800.800.7496 | 419.865.9497 | 419.865.9997 (FAX)
www.ransom-randolph.com

Ransom & Randolph GmbH
Leipziger Straße 40 | 04571 Rötha Germany
+49 342 06373999