THE IMPORTANCE OF GREEN MOR FOR AUTOCLAVE CRACKING

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Abstract

During production trials using a new slurry system containing nylon fiber, a seemingly anomalous observation was made. While clearly lower in Green MOR than the standard fiber/polymer system being used, shells made with the new test slurry produced fewer autoclave cracked molds during the trial. An investigation was made to determine the reason for this observation. Tests of Green MOR were made using the standard technique, which is bars dry and the test preformed at room temperature. This was compared, using various slurry systems, to MOR tests that more closely simulate conditions in the autoclave and flash fire dewax processes. Results of these tests indicate possible explanations why a shell system with substantially lower Green MOR produced fewer autoclave cracks.

Introduction

Earlier this year, we at Buntrock, performed a plant trial using Wex Chemicals Wexcoat binder system. This system contains Nylon fibers as the major additive to an otherwise normal or typical fused silica slurry. This “test” system was being compared to the customers “standard” shell system that is commercially available. The standard slurry contained an unknown type of fiber and substantial polymer additives. It is not the intent of this paper to present the details of that test, but the observations made during the test spawned research work that is important for the industry.

Test shells were hand dipped and were lighter in finished weight than standard robot dipped duplicate parts. It was expected that the test parts would yield poorly through dewax because of the low shell weights. In fact, just the opposite was observed. For all part numbers, observed dewax shell cracks were equivalent with the exception of the one really tough part that always cracked. On this part, the standard slurry had 100% cracking and the test molds showed 0% cracking.

While very pleasing, this result was not at all expected. MOR bars made from the test slurry were broken in the green state and compared to reported values for the standard slurry.

Slurry System	**Green MOR**
Standard	850 psi (reported as typical)
Test	400 psi

This lab data does not seem to support the physical results observed in the autoclave trials. Since polymer was used in the standard slurry and not in the test slurry, I decided to investigate the role of polymer in the dewax process. My basic hypothesis was that Green MOR does not accurately predict dewax cracking because green MOR is normally performed at or near 70 deg. F. while the autoclave process is about 325 deg. F and Flash Fire dewax processes are much higher. I expected the polymer would soften in both autoclave or flash fire dewax and thus loose some of its’ effectiveness resulting in lower MOR.

Experimental Procedure

Slurries

Ingredients	Slurry A %	Slurry B %	Slurry C %	Slurry D %
Nyacol 830	33.6	30.8	0.0	0.0
Megasol	0.0	0.0	41.5	39.3
Water	5.8	5.3	0.0	3.1
Latex Polymer	0.0	3.2	0.0	3.1
200 Fused Silica	40.6	40.6	39.0	38.4

Slurry Properties

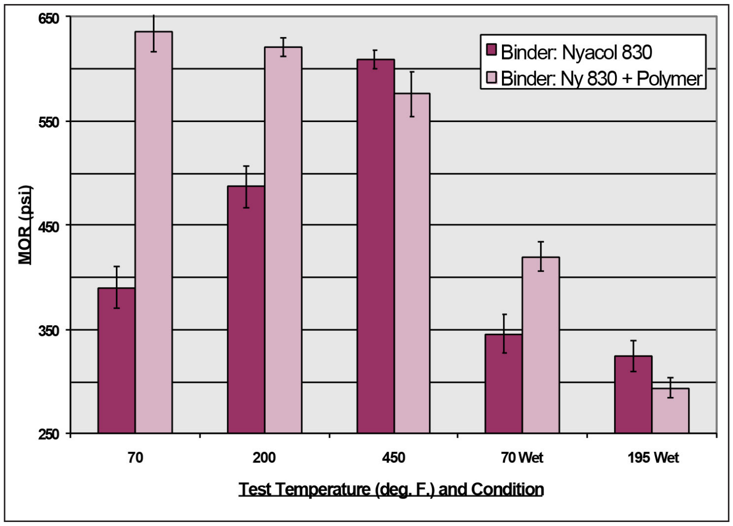
Ingredients	Slurry A %	Slurry B %	Slurry C %	Slurry D %
Binder % SiO2	25.5	25.6	45.0	45.0
Total Solids %	70.6	71.5	77.2	76.8
Viscosity #5	13.5	12.4	10.3	10.8
Zahn				

Sample Specimens

Wax bars 8" x 1.25" x 0.25" were dipped directly into these slurries without a prime dip. Sufficient surfactant was used for the slurry to wet the wax. The first dip was stuccoed with 50x10 fused silica. Second through fifth dip used 30x50 fused silica. Sixth dip was a seal coat. After final dry, bars were very carefully removed from the wax without heating. Ceramic did not stick to wax. Ceramic strips were thoroughly dried at room temperature. MOR was then determined at various temperatures and conditions.

Results

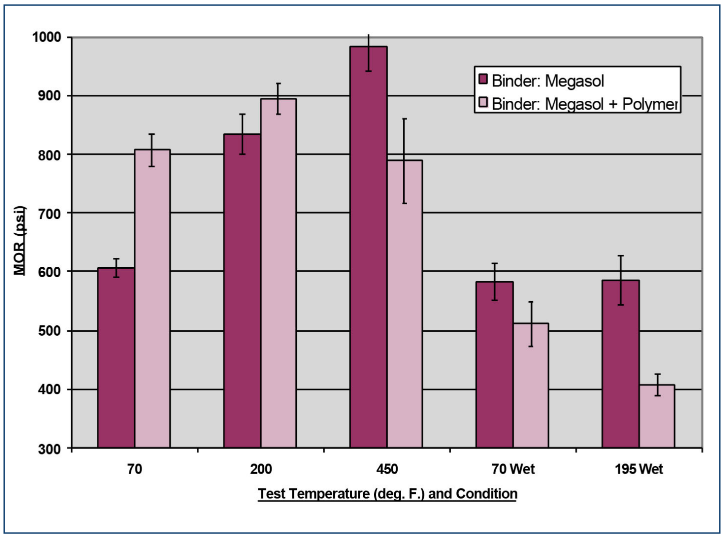
MOR Strength of Fused Silica Slurry at Various Dewax Conditions



Note: Error bars are 95% Confidence Intervals

Slurries using Megasol Binder and Polymer Additives

MOR Strength of Fused Silica Slurry at Various Dewax Conditions



Note: Error bars are 95% Confidence Intervals

CONCLUSIONS

1. For standard colloidal silica, the MOR value drops significantly when tested either wet (11% drop) or hot and wet (23% drop).
2. For colloidal silica with Polymer, the MOR drop is dramatic when tested either wet (34% drop) or hot and wet (54% drop).
3. The weakest condition occurs when using standard colloidal silica with polymer and tested hot and wet.
4. MOR values for high silica, low alkali Megasol colloidal silica are not affected by water or hot water.
5. Caution should definitely be used when trying to relate the standard room temperature MOR values to autoclave cracking results.
6. For flash fire conditions, MOR values increase substantially from room temperature to 450 deg. F. for shells made with colloidal silica and no polymer.
7. Any advantage to MOR imparted by using polymer is gone by 450 deg. F. Therefore, it is unlikely that polymer would help prevent cracks in flash fire situations.