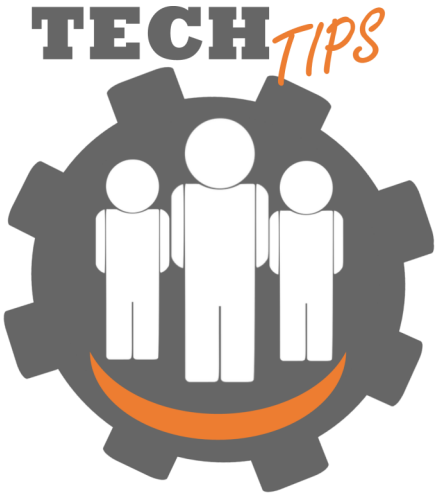
Slurry Control



Conducting regular testing is essential to best understand the properties of your slurry. To control the slurry in your foundry, Ransom & Randolph recommends conducting the following tests. For your convenience, automated Slurry Control Worksheets (Microsoft® Excel®) are available for download at www.ransom-randolph.com.

Slurry Viscosity

Check slurry viscosity at the beginning of each operating shift, at minimum. Deionized or distilled water should be added, as necessary, to reduce viscosity; which increases as a result of evaporation. The use of tap water may lead to premature gelation.

Slurry Density

Check slurry density weekly, at minimum. Slurry density should only be measured on a stable slurry within the target viscosity range. The slurry density should be maintained ± 0.02 g/ml from the target density. If slurry density deviates out of this range, then a total solids test should be performed.

1. Weigh a 100 ml graduated cylinder or volumetric flask. Enter value into H1 in the Slurry Control Worksheets.
2. Fill with well mixed slurry to 100 ml line and reweigh. Enter value into H2 in the Slurry Control Worksheets.
3. The calculated slurry density will be displayed in H3 in the Slurry Control Worksheets.

Note: weekly slurry density testing is not required for primary slurries.

Total Slurry Solids & Refractory Solids

Check total slurry solids weekly, at minimum. Total slurry solids is the combination of binder solids and refractory solids. The total slurry solids calculation is required to determine the refractory solids percentage. Uncontrolled refractory solids can lead to weak (too low) or brittle (too high) shells. High refractory solids can cause shell cracking and make the shell difficult to remove. Control refractory solids to the appropriate range. The Slurry Control Worksheets automatically calculate the appropriate addition to bring the refractory solids into the proper range and will be displayed in G2. The following procedure should be used to check that refractory solids are maintained in the recommended range.

1. Weigh a metal drying pan on a scale accurate to 0.01 grams. Enter value into I1 in the Slurry Control Worksheets.
2. Place approximately 10 grams of well mixed slurry in the pan and reweigh the wet sample and pan. Enter value into I2 in the Slurry Control Worksheets.
3. Dry the sample and pan in the oven at 350°F (177°C) for 1 hour.
4. Weigh the dry sample and pan. Enter value into I3 in the Slurry Control Worksheets.
5. The calculated total slurry solids will be displayed in I4 in the Slurry Control Worksheets.

Note: weekly total slurry solids testing is not required for primary slurries.

Binder Solids & Specific Gravity

Check binder solids two times per week, at minimum. Binder solids include SiO_2 and other solids (i.e., polymer) in the binder. The specific gravity calculation is required to determine the binder solids percentage. Uncontrolled binder solids can affect the life of the slurry and the performance of the shell (resulting in weak shells). Binder solids must be controlled in the appropriate range. A gelation test should be performed if binder solids are out of control. Binder solids target ranges are included in the Slurry Control Worksheets.

1. Collect four 50 ml tubes of slurry and centrifuge at 3,500 rpm for 30 minutes.
2. Decant the pourable portion from the tubes into a clean container.
3. Weigh a calibrated 10 ml volumetric flask on a scale accurate to 0.01 grams. Enter value into J1 in the Slurry Control

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Worksheets.
4. Transfer the sample with a pipette or eyedropper into a volumetric flask (the meniscus of the liquid should touch the volume line on the flask).
5. Reweigh the flask and sample. Enter value into J2 in the Slurry Control Worksheets.
6. The calculated binder solids will be displayed in C4 in the Slurry Control Worksheets.
7. The Slurry Control Worksheets automatically calculate the appropriate water addition to bring the binder solids into the proper range and will be displayed in E2.

Binder pH

Check binder pH with a pH meter weekly, at minimum. Binder pH is a reflection of binder stability. Colloidal silica binder is alkaline and becomes unstable as pH drops. Too low of a pH will lead to gelation of the binder/slurry. Normally the pH of your slurry binder will not vary much. If the slurry pH falls below 9.25, a gelation test should be performed to determine the stability of the slurry. To determine pH, use the samples gathered for binder solids or prepare a slurry binder sample (steps 1-2 of the binder solids calculation).

1. Pour well mixed binder into a clean container.
2. Measure the pH using a calibrated pH meter (see meter instructions for procedure). If pH is 9.25 or below, make adjustments to stop/slow down further pH drop. To do this, make a solution of either 150 ml of reagent grade ammonium hydroxide or 80 ml of Triethanolamine (TEA) in 1 gallon of deionized water. Use water solution to adjust for viscosity or high binder solids, as warranted.

Note: Keycote® slurries do not require pH testing.

Gelation Test

Perform a gelation test, as needed based on pH and binder solids testing results. The gelation test is an accelerated aging test that determines the approximate stability, or life left, in a particular slurry. A thickening, or gelled slurry, can lead to casting defects (surface conditions) and weak shells (cracking). Any slurry that gels in 24 hours is near the end of its useful life and should be discarded.

1. Prepare a slurry binder sample (steps 1-2 of the binder solids calculation).
2. Pour 10-20 ml of binder into a sealable container capable of handling 150°F (66°C).
3. Place the sealed container into an oven controlled at 140°F ± 5°F (60°C ± -15°C) for 24 hours. Observe the viscosity of the liquid. If viscosity thickens, slurry is gelling. In this case, repeat the test frequently to the determined slurry endpoint. If the liquid is solid, the slurry should be discarded immediately.

Antifoam Test

Perform an antifoam test weekly, at minimum. Various conditions, such as high binder solids, excess wetting agent, temperature and excessive shear, degrade the antifoaming characteristics of a slurry and an antifoam test should be conducted to check for the presence of adequate antifoam.

1. Prepare a slurry binder sample (steps 1-2 of the binder solids calculation).
2. Pour 10-20 ml of binder into a test tube or other container that can be tightly sealed.
3. Shake the sample vigorously for 5 seconds.
4. Observe the binder and note the time for the foam to dissipate.
   a) If the foam breaks in less than 20 seconds, the antifoam level is acceptable.
   b) If the foam breaks in more than 20 seconds, make a 1-3 ml/gallon of slurry addition of DCH-10 antifoam.

Slurry Log

R&R recommends maintaining a detailed slurry log of refractory, binder, water additions and other checks.

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Slurry Log

Tank #: ______________________ ☐ Primary ☐ Backup

Date Slurry Originated: ______________________ ☐ Other: ______________________

A. **Binder:** ______________________ Grade: ____________ Original Quantity: ____________ weight ____________ %

B. **Refractory #1:** ______________________ Mesh: ____________ Original Quantity: ____________ weight ____________ %

C. **Refractory #2:** ______________________ Mesh: ____________ Original Quantity: ____________ weight ____________ %

D. **Water:** Original Quantity: ______________________ Total: ____________ weight ____________ %

E. **Other:** ______________________ Original Quantity: ______________________

Slurry Binder Solids: Min: ____________ % Max: ____________ % **pH:** Min: ____________ Max: ____________

Refractory Solids: Min: ____________ % Max: ____________ % **Density:** Original: ____________ ±0.01 gm/ml

Viscosity: Zahn Cup #: ______________________ Min: ____________ sec. Max: ____________ sec.

Date	Time	Viscosity	Density	Binder Solids	pH	Refractory Solids	Tank Volume	Additions	Initials