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BUNTROCK INDUSTRIES

BUNTROCK LABORATORY TESTING PROCEDURES

STEP-BY-STEP INSTRUCTIONS FOR TESTING, SAMPLING AND OPTIMIZING INVESTMENT CASTING SLURRIES

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BI 1109 SLURRY PROCESS CONTROL

Document No: 7.33

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	03/04/14

1.0 Scope:

The slurry control tests in this procedure are considered a minimum level of tests and frequency for reasonable process control of back up slurry.

2.0 Purpose:

The intended use for these tests is to provide the foundry with the tools needed to control its back up slurry process. Each foundry needs to establish the frequency and the operating tolerance of each test they choose to implement to control their process.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Equipment for the Slurry Viscosity- Flow Cup Method test as per document 7.1.
4.2 Equipment for the Slurry Binder Specific Gravity and Silica Content test as per document 7.16.
4.3 Equipment for the Slurry Density – Graduated Cylinder Method as per document 7.31.
4.4 Equipment for the Slurry Bacteria test as per document 7.15.
4.5 Equipment for the slurry pH test as per document 7.7.

5.0 Procedure:

5.1 Check the viscosity frequently using a BI Brass Cup and referring to document 7.1. Maintain a range of +/- 0.75 seconds. Frequency depends on amount of dipping relative to the size of the tank and environmental factors like airflow and temperature.
- Thin the slurry with a 50/50 mixture of binder and water during production dipping.
- Use only water if slurry is not in use. Overnight as an example.
- If possible add water before leaving slurry idle for extended periods of time to account for evaporation.

5.2 For TMM30 binder check binder silica level as necessary to maintain a silica level of 26-28% referring to Slurry Binder Specific Gravity and Silica Content document 7.16. Find % SiO_2 on TMM30 density chart. Note that the centrifuged binder will still be somewhat dark in color.

5.3 Check the slurry density according to document 7.31. The result should be 1.59 – 1.67 grams/ml. The result depends on individual circumstances like type of binder, intensity of mixing, whether or not surfactant is used, and slurry viscosity. The above range covers that normally encountered in the field. Once established a tighter range is possible.

5.4 Check bacteria levels every two weeks referring to document 7.15. Use Stepanquat to kill bacteria. Use bleach to rinse tanks, pumps, and hoses for good hygiene.

5.5 Check the pH of the slurry weekly using the procedure in document 7.7. Usually the first sign of bacteria is a drop in slurry pH. Acceptable range is 9.4 – 10.5. Use TEAH to adjust slurry pH upward, if needed.

6.0 Results:

See section 5.0 Procedures for recommendations on how to interpret the results of the tests in this document.

7.0 References:

None.

BI 2010C SLURRY PROCESS CONTROL

Document No: 7.34

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	03/07/14

1.0 Scope:

The slurry control tests in this procedure are considered a minimum level of tests and frequency for reasonable process control of back up slurry.

2.0 Purpose:

The intended use for these tests is to provide the foundry with the tools needed to control its back up slurry process. Each foundry needs to establish the frequency and the operating tolerance of each test they choose to implement to control their process.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Equipment for the Slurry Viscosity- Flow Cup Method test as per document 7.1.
4.2 Equipment for the Slurry Binder Specific Gravity and Silica Content test as per document 7.16.
4.3 Equipment for the Slurry Density – Graduated Cylinder Method as per document 7.31.
4.3 Equipment for the Slurry Bacteria test as per document 7.15.
4.4 Equipment for the slurry pH test as per document 7.7.

5.0 Procedure:

5.1 Check the viscosity frequently using a BI Brass Cup and referring to document 7.1. Maintain a range of +/- 0.75 seconds. Frequency depends on amount of dipping relative to the size of the tank and environmental factors like airflow and temperature.

- Thin the slurry with a 50/50 mixture of binder and water during production dipping.
- Use only water if slurry is not in use. Overnight as an example.
- If possible add water before leaving slurry idle for extended periods of time to account for evaporation.

5.2 For TMM30 binder check binder silica level as necessary to maintain a silica level of 26-28% referring to Slurry Binder Specific Gravity and Silica Content document 7.16. Find % SiO_2 on TMM30 density chart. Note that the centrifuged binder will still be somewhat dark in color.

5.3 Check the slurry density according to document 7.31. The result should be 1.59 – 1.67 grams/ml. The result depends on individual circumstances like type of binder, intensity of mixing, whether or not surfactant is used, and slurry viscosity. The above range covers that normally encountered in the field. Once established a tighter range is possible.

5.4 Check bacteria levels every two weeks referring to document 7.15. Use Stepanquat to kill bacteria. Use bleach to rinse tanks, pumps, and hoses for good hygiene.

5.5 Check the pH of the slurry weekly using the procedure in document 7.7. Usually the first sign of bacteria is a drop in slurry pH. Acceptable range is 9.4 – 10.5. Use TEAH to adjust slurry pH upward, if needed

6.0 Results:

See section 5.0 Procedures for recommendations on how to interpret the results of the tests in this document.

7.0 References:

None.

SLURRY BACTERIA TEST

Document No: 7.15

Revision	Description of Change	Author	Date
0	Initial Release	Tim George	01/12/14

1.0 Scope:

This procedure describes a method for detecting the presence of microbial growth within water-based slurries.

2.0 Purpose:

This is an easy test to monitor the presence/absence of harmful bacteria growth, which can degrade the stability of slurries. Unusual or unpleasant odors are also evidence of bacteria growth.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Culture slide, such as MCE Combi dip slide or equivalent.
4.2 Eye dropper (optional).
4.3 50 ml tubes.
4.4 50 ml beaker or vial.
4.5 Biocides.

5.0 Procedure:

5.1 Obtain sample of binder extracted from slurry per section 7.13.
5.2 Unscrew the cap and withdraw the cap and slide from the vial. Be careful not to touch the agar coated surface of the slide.
5.3 Cover the agar surface of the slide with test binder by either dipping it into the binder for a minimum of three seconds or by using an eye dropper.
5.4 Allow excess fluid to drain from the slide.
5.5 Screw the cap back on lightly and then back it off one half turn. Incubate the vial in an upright position at 77° to 86° F (25° to 30° C) for 24 to 48 hours.
5.6 Compare the results against the Colony Density Chart provided by the manufacturer of the slide.
5.7 Be sure to keep accurate records, in chronological order, for each slurry

6.0 Results:

If bacteria growth is detected, contact supplier for recommendations to eliminate bacteria, including use of biocides. Finding the cause of contamination must be done to prevent reoccurrence of the problem. Check any container that may have either direct or indirect contact with the slurry.

7.0 References:

None.

SLURRY BINDER SEPARATION

Document No: 7.13

Revision	Description of Change	Author	Date
0	Initial Release	Tim George	01/12/14

1.0 Scope:

This procedure describes a method for extracting the colloidal silica binder from waterbased slurry.

2.0 Purpose:

Extracting the binder phase from a slurry is important because it allows the foundryman to test the quality of the binder being used in production slurry tanks. Binder stability is critical to mold and casting quality because the binder affects key shell mold properties such as strength.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Centrifuge equivalent to Fischer Model #255 with rotor and 50 ml centrifuge tubes.
4.2 Disposable pipette or eye dropper or syringe.
4.3 Sample vial.

5.0 Procedure:

5.1 Place equal quantities of slurry sample in an even number of 50 ml centrifuge tubes. Attach caps and place tubes opposite to one another in the centrifuge rotor. The slurry sample should be at room temperature.
Note: For some slurries, it will help to draw a large sample of the slurry and allow it to settle overnight before drawing partially settled liquid off the top to feed the centrifuge tubes. Be sure that the sample is covered while it is settling to prevent evaporation.

5.2 Run the centrifuge at 5000 rpm for 10 minutes, then allow centrifuge to come to a slow stop without braking.

5.3 Carefully remove caps from the centrifuge tubes so as not to disturb the samples. With a disposable pipette, draw off the liquid portion in each tube and transfer to a clean dry vial that has been labeled accordingly. Be very careful to avoid drawing up unsettled refractory into the pipette.
Note: Some binders contain organic liquids such as latex and these liquids are likely to separate from the water during centrifuge operation. Check with binder supplier to determine which liquid portion(s) should be included in the sample.

5.4 Repeat items 5.1 through 5.3 until at least 10 ml of extracted binder has been collected.

6.0 Results:

Refer to the following tests in the Buntrock Industries procedures for tests to be done on extracted binder.

Section	Description
7.14	Slurry Gelation Test
7.15	Slurry Bacteria Test
7.16	Slurry Binder Specific Gravity and Silica Content
7.18	Slurry Foam Test

7.0 References:

None.

SLURRY BINDER SOLIDS

Document No: 7.32

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	06/02/14

1.0 Scope:

This test is used to determine the solids content (i.e. colloidal silica plus additive) of colloidal silica extracted from a slurry by evaporating to dryness in an oven. The weight of the residual solids is then measured and compared to the beginning weight to determine percent solids.

2.0 Purpose:

The solids content of slurry binder affects mold quality and casting quality. As a result, this test can be used as a control test. Variation in binder solids content will affect mold strength and slurry stability.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Aluminum foil dish.
4.2 Oven capable of at least 140° C.
4.3 Balance capable of weighing to at least 0.01 grams.

5.0 Procedure:

5.1 Obtain sample of test binder extracted from slurry per section 7.13.
5.2 Weigh an aluminum foil dish and record the weight.
5.3 Add homogenous binder to the dish, weigh and record the weight.
5.4 Dry the sample in an oven at 140° C for one hour.
5.5 Weigh the sample and return it to the oven for another 30 minutes.
5.6 Weigh the sample again and if it is the same as was measured in step 5.5, record the weight. If the weight changed, continue drying until the weight stops changing. Do not allow the sample to sit before weighing as it may re-absorb some of the moisture it lost in the oven.
5.7 Calculate the percent solids using the following formula:

$$\frac{\text{Dry Slurry} - \text{Pan X 100} = \text{Percent Solids}}{\text{Wet Slurry} - \text{Pan}}$$

6.0 Results:

If the binder solids fall outside established control limits, the slurry should be pulled from production until corrective action has been completed and verified.

7.0 References:

None.

SLURRY BINDER SPECIFIC GRAVITY AND SILICA CONTENT

Document No: 7.16

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	02/04/14

1.0 Scope:

This procedure describes the determination of the specific gravity of the binder phase.
This information can be used to determine the binder silica content.

2.0 Purpose:

The silica content of slurry binder affects mold quality and casting quality. As a result, this test is often used as a key control test. Variation in binder silica content will affect mold strength and slurry stability.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Container-Volumetric Flask-10 ml. (Fisher No. 10-199-10A or equivalent) or 10 ml pynchnometer.
4.2 Balance capable of weighing to 0.01 gm. (fisher No. 2-021 or equivalent).
4.3 Eye dropper.

5.0 Procedure:

5.1 Obtain sample of binder extracted from slurry per section 7.13, and adjust to 77° F (25°).
5.2 Weigh a clean, dry 10 ml. container to the nearest 0.01 gm (WF).
5.3 Transfer the sample to the tared 10 ml container.
- Fill the volumetric flask to its mark (note the bottom of the meniscus of the liquid should be at the line) and weight of the 10 ml liquid sample determined to the nearest 0.01 gm (WB).
- Fill the pynchnometer and replace the lid. Any liquid displaced should be absorbed. (Note that some liquid should be displaced to insure the flask is completely filled.) The weight of the sample should be determined to the nearest 0.01 gm (WB).

5.4 Wash the flask free of binder, dry the outside, and fill to the mark with distilled water at room temperature. Weigh the contents again to the nearest 0.01 gm (WW).
5.5 The specific gravity is calculated as:
Specific Gravity = WB – WF/WW – WF

6.0 Results:

It is recommended to use the graph or chart of silica content vs. specific gravity to determine the silica content of the sample. If the silica content falls outside established control limits, the slurry should be pulled from production until corrective action has been completed and verified.

7.0 References:

None.

SLURRY DENSITY – GRADUATED CYLINDER METHOD

Document No: 7.31

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	02/06/14

1.0 Scope:

This procedure describes a method of determining the density of either water-based or alcohol-based slurries with the use of a 100 ml graduated cylinder.

2.0 Purpose:

Slurry density is a potential control parameter and is also used in calculating adjustments to slurries.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Calibrated 100 ml graduated cylinder.
4.2 Balance capable of weighing to at least 0.1 grams.

5.0 Procedure:

5.1 Be sure the slurry to be tested is thoroughly mixed and homogenous.
5.2 Tare a clean, calibrated 100 ml graduated cylinder on balance.
5.3 Fill graduated cylinder with test sample.
5.4 Weigh full graduated cylinder and record value to nearest 0.1 grams.
5.5 Divide weight in grams by 100 to calculate the density in grams/milliliter.

6.0 Results:

Compare to internal controls.

7.0 References:

None.

SLURRY FOAM TEST

Document No: 7.18

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	02/04/14

1.0 Scope:

This test is designed to indicate how quickly air bubbles break on molds during the slurry draining process for slurries that use colloidal silica binder.

2.0 Purpose:

Air bubbles that appear on molds during the draining process should break quickly to improve surface quality in the case of prime dips and to reduce the risk of positive metal defects in the case of back-up dips. As a result, this test is used as a control to assess how well antifoam additives are working.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Centrifuge tube.
4.2 Stop watch.
4.3 Antifoam agent.

5.0 Procedure:

5.1 Obtain sample of binder extracted from slurry per section 7.13.
5.2 Place approximately 10 ml of sample binder in a fresh centrifuge tube and attach cap.
5.3 Simultaneously begin shaking the centrifuge tube containing the sample and start stopwatch. After 10 seconds, stop shaking the tube and restart stop watch. Observe any foam that may appear on top of the binder and stop the stopwatch once all the foam has disappeared.
5.4 Record results along with date and slurry tank.

6.0 Results:

If foam disappears within 30 seconds, the slurry has passed the test and no further action is required.
If foam disappears after 30 seconds, the slurry has failed. Add antifoam to slurry per recommendations of binder supplier and retest the slurry for conformance. Be careful not to overdose with antifoam.

7.0 References:

None.

SLURRY GELATION TEST

Document No: 7.14

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	01/12/14

1.0 Scope:

This procedure describes a method for determining the quality of the liquid portion (i.e. binder plus additives) of water-based slurry by means of a gelation test.

2.0 Purpose:

This is an accelerated gelation test that will indicate the stability of slurry binder. This information is very important in assessing the overall quality of the slurry and the risk of gelation.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Oven capable of 140° F + 5° F (60° C + 2° C).
4.2 Sample containers with tightly fitted caps (20 to 200 ml capacity).
4.3 Plastic wrap such as Saran Wrap.
4.4 Fresh binder for use as a standard.

5.0 Procedure:

5.1 Obtain sample of test binder extracted from slurry per section 7.13. Fill the sample container about half to two-thirds full with test binder. Record or mark on the container the liquid level.
5.2 Place plastic wrap over mouth of container, then tightly cover with the cap. Note that plastic wrap is intended to help prevent evaporation loss during time in oven.
5.3 Place in oven held at 140° F + 5° F (60° C + 2° C) for one week.
5.4 Repeat items 5.1 to 5.3 with sample container filled with fresh binder for use as a standard.
5.5 On a daily basis, visually observe the viscosity of the sample; compare it to the standard and record results. Also check the liquid level and abort test if liquid level drops which indicates unacceptable evaporation loss.

6.0 Results:

6.1 If viscosity of test sample, as in item 5.5, is similar to standard, quality is acceptable.

6.2 If viscosity of test sample has increased relative to standard, polymerization is occurring and the test sample is beginning to gel.

6.3 If sample binder gels, the slurry is at risk and plans should be made to discard the slurry. Note that the gelation test accelerates events approximately 7 to 10-fold. For example, one day at 140° F (60° C) is equivalent to approximately 7 to 10 days at ambient temperature.

7.0 References:

None.

SLURRY PH

Document No: 7.7

Revision	Description of Change	Author	Date
0	Initial Release	Tim George	01/12/14

1.0 Scope:

This procedure describes a method for determining the quality of the liquid portion (i.e. binder plus additives) of water-based slurry by means of a gelation test.

2.0 Purpose:

pH testing can aid in avoiding conditions that can cause gelling of the slurry because most colloidal silica binders are stable only within a certain pH range. This acceptable pH range is provided by the supplier of the colloidal silica. As the pH of slurry shifts closer to pH limits, it is at greater risk for gelling.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 pH Meter accurate to 0.01 pH units;
4.2 Beaker such as Fisher Scientific No. 02-593-50C.
4.3 Thermometer accurate to within + 1 degree F (0.5 degrees C).j
4.4 Buffer solutions for calibrating pH meter.
4.5 Accumet Electrode – Fischer Scientific Catalog 13-660-62 or equivalent.
4.6 Glass Electrode – Fischer Scientific Catalog 13-620-284 or equivalent.

5.0 Procedure:

5.1 Follow manufacturer's recommended procedure to check for proper function of electrodes.
5.2 Standardize meter with buffer solutions at each end of range to be measured.

- Note: Always rinse electrodes with distilled water and pat dry with a tissue after removing electrodes from a buffer or a slurry sample.
- Also, buffer solutions have a limited life once they have been opened. Refer to manufacturer's manual for storage and shelf life instructions.

5.3 Place slurry sample (approximately 200 ml. is adequate) in clean beaker.
5.4 Measure and record slurry temperature.
5.5 Immerse electrodes in slurry and read pH once it has stabilized. Repeat items 5.1 to 5.3 with sample container filled with fresh binder for use as a standard. On a daily basis, visually observe the viscosity of the sample; compare it to the standard and record results. Also check the liquid level and abort test if liquid level drops which indicates unacceptable evaporation loss.

5.6 Record pH. Be sure to keep accurate records, in chronological order for each slurry. As soon as pH electrode is removed from slurry, rinse immediately and thoroughly with distilled water. Cleanliness is vital for accuracy and long life of electrodes.

5.7 Follow manufacturer's instructions for storage of pH meter and electrodes.

5.8 PH changes can be caused by various factors and there are options with regard to controlling and/or responding to pH changes in productions slurries. The supplier of the colloidal silica should be consulted to review these options and to develop a control plan.

6.0 Results:

PH results should be recorded on control charts for each slurry and a base line should be established for each slurry to characterize its behavior.

7.0 References:

None.

SLURRY TEMPERATURE

Document No: 7.7

Revision	Description of Change	Author	Date
0	Initial Release	Tim George	01/12/14

1.0 Scope:

This procedure describes a method for measuring the temperature of water-based slurry. Slurry temperature is a factor that should be controlled to produce consistently good shell molds.

2.0 Purpose:

Slurry temperature is an important factor to control because temperature affects binder stability, drying behavior, and therefore mold quality. For example, as slurry temperature increases, binder stability decreases and rate of drying increases. If this condition is not accommodated, mold quality will suffer with increased risk of casting defects such as run-outs and inclusions.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

A partial immersion glass thermometer or digital thermometer capable of being read to 0.5° F (-17° C).

- Note that immersion thermometers have a line above the bulb that indicates the depth to which the thermometer should be dipped into the slurry to give an accurate reading.

5.0 Procedure:

5.1 Immerse thermometer in the slurry and hold at this depth until the temperature stabilizes.

5.2 With thermometer still immersed, read the temperature to the nearest half-degree.

5.3 Remove thermometer from the slurry and clean it immediately.

- Note: Thermometers are fragile and must be handles carefully during use.Thermometers must be regularly calibrated.

5.4 Record results on a control chart such as an I Chart or Xbar/R Chart. If temperature falls outside established tolerance band, then production should be stopped until corrective action brings slurry temperature back into control.

6.0 References:

None.

SLURRY TOTAL SOLIDS

Document No: 7.11

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	02/12/14

1.0 Scope:

This test determines the total solids content of a slurry by evaporating to dryness in an oven. The weight of the residual solids is then measured and compared to the beginning weight to determine the percent solids. For this test, solids are defined as all material that will not be driven off at 120° C, which includes the organic additives contained in some colloidal silica binders.

2.0 Purpose:

The total solids content of a slurry is not generally used as a control test for production slurries. It can however, be useful as a quality check when new slurries are made or when problems demand an increase in the slurry testing campaign. As a result, it is best practice to establish a data base for each slurry formulation by measuring total solids content on at least one slurry that is made under close supervision.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Aluminum foil dish.
4.2 Oven capable of at least 120° C.
4.3 Balance capable of weighing to at least 0.01 grams.

5.0 Procedure:

5.1 Weigh an aluminum foil dish and record the weight.
5.2 Add homogenous slurry to the dish (about 50 grams), weigh and record the weight.
5.3 Dry the sample in an oven at 120° C for one hour.
5.4 Weigh the sample and return it to the oven for another 30 minutes. Be sure to protect the balance from the heat of the dish.
5.5 Weigh the sample again and if it is the same as was measured in step 5.4, record the weight. If the weight changed, continue drying until the weight stops changing. DO not allow the sample to sit before weighing as it may re-absorb some of the moisture it lost in the oven.
5.6 Calculate the percent solids using the following formula:

$$\frac{\text{Dry Slurry} - \text{Pan}}{\text{Wet Slurry} - \text{Pan}} \times 100 = \text{Percent Solids}$$

6.0 Results:

If the total solids content of a slurry falls outside its established target value, the slurry should be pulled from production until corrective action is completed. There are multiple causes for deviations of total solids content, and other slurry tests are needed in conjunction with total solids to find root cause. A new slurry, for example, that is otherwise under control may have been made with incorrect material, which would cause total solids content to be suspect even though slurry viscosity is within tolerance.

7.0 References:

None.

SLURRY VISCOSITY – FLOW CUP METHOD

Document No: 7.1

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	02/04/14

1.0 Scope:

This procedure describes a method of indirectly measuring the viscosity of slurries by means Of a metal flow cup in which the time in seconds is determined for a constant amount of slurry to flow through the orifice in the bottom of the cup. Various cups are in use in the industry and each cup gives a different reading. This test is applicable to both water-based and alcohol-based slurries.

2.0 Purpose:

The flow cup method for measuring slurry viscosity is one of the most widely used control tests. Controlling viscosity by adding water to counteract evaporation losses allows the foundryman to produce consistently even prime and backup coats.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Thermometer per section 7.6 Slurry Temperature.

4.2 Stopwatch.

4.3 Viscosity cup such as Zahn Signature, Zahn EZ, Mini ISO and Boekel cup.
Note: Cup selection also involves selecting the cup number that reflects the diameter of the cup's orifice. In general, viscosity cups are selected so that slurries drain from cup within 10 to 50 seconds. As a result, cups with large orifices will be used on thicker slurries (i.e. prime dip slurries) and cups with smaller orifices will be used on thinner slurries (i.e. backup dip slurries.

5.0 Procedure:

5.1 Make sure the cup is clean.

5.2 Make sure that sample is homogeneous. Screen a sample to make sure no clumps of material are present.

5.3 Measure and record slurry temperature per section 7.6 Slurry Temperature.

5.4 Hold the cup in a vertical position by means of the small ring at the top of the handle and dip it into the slurry to be tested.

5.5 Simultaneously lift the cup quickly out of the slurry and perform the following operations:

- Start the stopwatch when the top edge of the cup breaks the surface.
- Raise the cup well above the surface in one smooth, continuous motion.

- Stop the stopwatch when the steady flow of slurry from the orifice suddenly stops or a break in the stream is detected. When using smooth flowing liquids, the break point is usually measured at 4 inches from the bottom of the cup. For many slurries, this point is difficult to read and a point at 1 inch or less is used. At some foundries, the technician will look into the cup and stop the watch when an outline of the hole is seen in the bottom of the cup. In any case, be consistent.

YTTRIA PRIME SLURRY MAINTENANCE

Document No: 7.39

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	01/21/15

1.0 Scope:

This procedure describes the method for maintaining a yttria prime slurry made using T-123 binder and Buntrock yttria blend.

2.0 Purpose:

Proper slurry maintenance is extremely important for yttria slurries. In addition to the usual controls, the pH must be kept between 10 -11 to get maximum slurry life and performance. This document outlines the steps for proper maintenance of a Buntrock yttria slurry.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Equipment for Slurry Viscosity – Flow Cup Method, document 7.1.
4.2 Equipment for Slurry pH, document 7.7.
4.3 Equipment for Slurry Binder Specific Gravity and Silica Content, document 7.16.
4.4 Equipment for Slurry Density – Graduated Cylinder Method, document 7.31.
4.5 Equipment for Slurry Bacteria, document 7.15

5.0 Procedure:

5.1 Slurry may be kept in an open slurry tank or in a closed container while being rolled but a closed container is preferred.

5.2 Check the viscosity frequently using a #5 Zahn cup and referring to document 7.1. Maintain a range of +/- 0.75 seconds. Frequency depends on amount of dipping relative to the size of the slurry container and environmental factors like airflow and temperature.

- Thin the slurry with a 50/50 mixture of binder and water during production dipping.
- Use only water if slurry is not in use and is kept in an open container. A closed container is recommended.

5.3 Check the pH of the slurry at least once a day using the procedure in document 7.7. If the pH is below 10.0, use TEAH to adjust the pH upward.

6.0 Results:

See section 5.0 Procedures for recommendations on how to interpret the results fo the tests in this document.

7.0 References:

Buntrock yttria prime slurry typical properties:

- pH = 10 – 11
- Slurry Density = 2.95 Kg/liter
- Solids Content = 83.0 – 84.0%
- Binder Density = 1.06 g/cc

YTTRIA PRIME SLURRY MAKEUP

Document No: 7.38

Revision	Description of Change	Author	Date
0	Initial Release	Joe Norvell	11/21/14

1.0 Scope:

This procedure describes the method for making a yttria prime slurry using T-123 binder and Buntrock yttria blend.

2.0 Purpose:

This instruction contains the formula and procedure for making a yttria prime slurry. The formula is given to make one liter of slurry. Use the volume of the tank the slurry will go in and how full the tank will be, making sure to leave a few centimeters of room at the top, to determine the number of liters of slurry to make. Multiply the number of liters of slurry being made by the formula for one liter given in the reference section of this procedure.

3.0 Hazard and Safety:

Consult the Material Safety Data Sheet (MSDS) for required handling procedures and Personal Protective Equipment (PPE) required.

4.0 Equipment

4.1 Slurry tank with a mixer.
4.2 A high shear mixer for slurry makeup if one is available.
4.3 A #5 Zahn Cup.
4.4 A scale to measure ingredients with.
4.5 The following ingredients:

- Distilled or deionized water
- T-123 Binder (equal weights of Ti Bond A and Ti Bond B mixed together)
- Buntrock blended yttria flour
- PS 9400 Surfactant
- Antifoam 2004

5.0 Procedure:

5.1 Use the reference below and the tank volume to figure how much slurry to make
5.2 Mix equal weights of Ti Bond A and Ti Bond B to make an amount of T-123 that is needed for the slurry.
5.3 Add the T-123 binder to the tank.
5.4 Add the appropriate amount of clean water to the tank.
5.5 Add half the total amount of Antifoam 2004.
5.6 Slowly add the Buntrock yttria blend to the liquid while mixing. Use a high shear mixer for makeup if one is available. Frequently stop the mixer to allow air to escape from slurry.

5.7 After all flour has been added and the slurry is almost completely de-aired, add the surfactant and remaining Antifoam 2004, if needed. Use the minimum amount of antifoam to achieve a state where most or all of the bubbles break during draining of the slurry prior to stucco application.

5.8 Adjust the viscosity to between 15 and 20 seconds on a #5 Zahn by adding binder or Buntrock blended yttria flour

5.9 Slurry may be used after a short cream out period if a high shear mixer is used during makeup. Otherwise, let slurry properties stabilize before mixing. It is best to allow the slurry to mix overnight. Slurry thickening is often observed overnight and the slurry may need to be thinned the second day.

5.10 Please see document 7.39 for yttria slurry maintenance procedures.

6.0 Results:

Buntrock yttria prime slurry formula:

	WEIGHT %	1 LITER SLURRY
T-123 Binder	14.7	434 g
De-ionized Water	3.7	109 g
BI Blended Yttria	81.6	2407 g
Totals	**100.0**	**2950 g**

PS9400 Surfactant	1 gram per liter of slurry
Antifoam 2004	0.2 grams per liter of slurry or as required