Application Instructions
Primcote® binder
July 2009

Formulations

If you currently have a primary slurry formulation, use the same percentages and loadings of your current refractories.
The following formulations are for casters just starting out.

				Formula for 10 Gallons (lbs)						Formula for 10 Liters (kgs)					
	Intended Slurry Use	Target Slurry Density (g/ml)	Target Viscosity (sec/# 5 Zahn)	Primcote binder	Ranco-Sil™ 4 fused silica	Zircon (200 mesh)	Ranco-Sil™ 2 fused silica	Alumia silica M47-200ICC	Water	Primcote binder	Ranco-Sil™ 4 fused silica	Zircon (200 mesh)	Ranco-Sil™ 2 fused silica	Alumia silica M47-200ICC	Water
Primary Coats	Ferrous Option 1	2.150 -2.190	20-25	43.39	68.7	68.7	-	-	-	5.21	8.25	8.25	-	-	-
	Ferrous Option 2	2.990 -3.030	17-19	43.94	-	206.7	-	-	-	5.28	-	24.85	-	-	-
	Non-Ferrous	1.690 -1.730	22-27	46.99	95.4	-	-	-	-	5.65	11.47	-	-	-	-
Backup Coats	Fused Silica Option	1.660 -1.700	15-20	41.99	-	-	91.37	-	6.14	5.05	-	-	10.98	-	.74
	Alumino Silicate Option	1.880 -1.920	17-19	41.99	-	-	-	109.65	6.14	5.05	-	-	-	13.18	.74

Application Recommendations

1) **Remix the Primcote® binder prior to use** to insure a homogeneous blend of material.
2) For best results weigh all ingredients when making up a new slurry or making additions to an existing slurry.
3) As with any slurry the viscosity of the slurry must be stable before use. A stable viscosity is one that does not change by more than one second when checked at one hour intervals. Viscosity can be increased by adding more refractory and decreased by adding more binder.
4) No water is required when making new primary slurry, it is required later to replace water lost to evaporation. When water is needed, use distilled or deionized water as tap water contaminants can negatively affect slurry life.
5) When building the slurry, add the refractory(ies) last. If more than one refractory is used, add the lowest density refractory first: fused silicas (2.2 g/cc), alumino silicates (2.7 g/cc), zircon (4.5 g/cc). Add refractory slowly for best results.
6) Antifoam and wetting agents are already formulated into Primcote binder and other additions may not be compatible. Contact R&R's Technical Department before making additions to the slurry.
7) Patterns must be clean and free from silicones or other contaminants before dipping.
8) It is not usually necessary to use a prewet before applying the first primary coat to the wax pattern. If a prewet is needed, use Primcote binder only, without dilution or additives.

9) Prewet application of dilute Primcote binder is recommended between each primary coat. The Primcote binder should be diluted to 26% binder solids (binder to water ratio of 5.8:1 by volume, 6.9:1 by weight). Drain the prewet well so that no pockets of liquid are left on the pattern. If a second Primcote primary slurry is used and it has a lower viscosity, no intercoat prewet is needed.

Slurry Control Procedures

Software

A copy of the EXCEL-based slurry control worksheet for Primcote® binder slurries can be found on the R&R Website under Ceramic Shell Tips, FAQs, Tools in the navigation bar. (http://www.ransom-randolph.com/html/slurry_control_worksheets.html). Download the appropriate worksheet and save a copy. An example of the spreadsheet is shown on page three.

The worksheet is split into sections and has two ways to input data; directly (in the blue text areas) or the spreadsheet can help to calculate the values (in the red text areas).

Slurry Density Determination (Spreadsheet Section R)

Check after viscosity adjustments are made and slurry is stabilized.

1) Weigh a 100 ml graduated cylinder or flask (enter into R1)
2) Fill with well mixed slurry to 100 ml line and reweigh (R2)
3) Complete this step only if calculating manually, subtract the empty weight from the filled weight and divide the sum by 100 to determine density.

Binder Specific Gravity – Binder Solids Determination (Spreadsheet Section S)

We recommend checking Binder solids weekly. Binder solids content should normally be:

Primary slurries: 29.3-30.3% by weight
Backup slurries: 25.0-27.0% by weight

1) Collect four 50ml centrifuge tubes of slurry and centrifuge at 3500 rpm for 30 minutes
2) Decant the liquid from the tubes into two tubes and centrifuge at 3500 rpm an additional 30 minutes.
3) Decant the pourable portion from the tubes into a clean container and stir/remix this portion.
4) Weigh a 10 ml volumetric flask on a scale accurate to 0.01 grams (S1).
5) Transfer the sample to the flask with a pipette or eyedropper into the volumetric flask. The meniscus of the liquid should touch the volume line on the flask.
6) Reweigh the flask and sample (S2)

Complete steps 7 and 8 only if calculating manually:

7) Subtract the empty flask weight from the filled flask weight and divide the sum by 10 to determine binder specific gravity.
8) Using the determined specific gravity, locate the Binder Solids on the chart on page 4 to determine binder solids.

Binder Solids Adjustments

Binder Solids includes SiO_2 and other solids (i.e. polymer) in the binder. Uncontrolled Binder Solids can affect the life of the slurry and the performance of the shell. Binder Solids must be controlled in the appropriate range. The software program will automatically calculate the appropriate add (water or water/binder) based on the test results.

Total Slurry Solids (Spreadsheet Section Q)

Total Slurry Solids is the combination of Binder Solids and Refractory Solids. The Total Solids calculation is required to determine the Refractory Solids Percentage. This is done as follows:

1) Weigh a metal drying pan on a scale accurate to 0.01 grams (Q1).
2) Place approximately 10 grams of well mixed slurry in the pan and reweigh the wet sample and pan (Q2).
3) Subtract the pan weight (Step 1) from the wet sample and pan weight (Step 2) to determine the wet sample weight
4) Dry the sample and pan in the oven at 350F (177C) for one hour.
5) Weigh the dry sample and pan (Q3).

Complete steps 6-9 only if calculating manually:

6) Subtract the pan weight (Step 1) from the dry sample and pan weight (Step 5) to determine the dry sample weight.
7) Calculate total solids by dividing the dry sample weight (Step 6) by the wet sample weight (Step 3)
8) Determine percent water in the slurry by subtracting total solids (Step 7) from 1.0 and then multiply by 100.
9) Determine percent water in the binder by subtracting the percent binder solids (determined in Section S step 8) from 100.
10) Calculate the refractory solids by dividing the percent water in the slurry (Step 8) by the percent water in the binder (Step 9). Subtract this value from 1.0 and multiply by 100 to get refractory solids.

Refractory Solids Adjustment

Uncontrolled refractory solids can lead to weak (too low) or brittle shells (too high). Refractory solids should be controlled to the appropriate range. The software will automatically calculate the proper addition to bring the refractory solids into the proper range.

Binder pH Determination

The binder pH is a reflection of the 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. The binder pH should be checked at least weekly. The pH is determined as follows.

1) Use the samples gathered for Binder Solids Determination or prepare a slurry binder sample by following steps 1-3 of the Binder Solids Determination above.
2) Pour well-mixed binder into a clean container
3) Measure the pH using a calibrated pH meter (see meter instructions for procedure).

Binder pH Adjustment

When the pH of the binder falls outside the acceptable 9.25-10.5 range, a gelation test should be performed to determine slurry stability. Adjustments should be made to stop/slow down further pH drop. To do this, make a solution of either 150 ml of reagent grade ammonium hydroxide in 1 gallon of deionized water OR 80 ml of Triethanolamine (TEA) in one gallon of deionized water. This water solution should be used to adjust for viscosity or high binder solids as warranted.

Gelation Determination

The gel test is an accelerated aging test that can be done to determine 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. Some foundries have found that they discard slurries when slurry fails a gel test at some other timeframe (e.g. 48 hours) they have determined is detrimental to their casting surface or integrity. The gel test is run as follows:

1) Prepare a slurry binder sample by following steps 1-3 of the Binder Solids Determination above.
2) Pour 10-20 ml of well mixed binder into a sealable container capable of handling 150 F.
3) Place the sealed container into an oven controlled at 140 F +/-5 F for 24 hours. Observe the viscosity of the liquid. If viscosity has thickened, slurry is gelling and test should be run frequently to the determined slurry endpoint. If liquid is solid, slurry should be discarded immediately.

Antifoam Test

Various conditions, such as high binder solids, can degrade the antifoaming characteristics of Primcote binder. To test for the presence of adequate antifoam:

1) Add approximately 10-20 ml of binder that has been centrifuged or separated from the slurry to test tube or other container that can be sealed tightly.
2) Shake the sample vigorously for 5 seconds.
3) Observe the binder and note the time for the foam to dissipate.
4) If the foam breaks in less than 20 seconds, the antifoam level is okay.
5) If the foam breaks in more than 20 seconds, a 1-3 ml/gallon of slurry addition of DCH-10 antifoam should be made.

Safety

OSHA approved respiratory protection should always be worn to avoid inhalation of respirable silica dust, which can result in irreversible lung disease, silicosis. Such exposure includes slurry makeup, casting, knockout and cleanup. Refer to MSDS for specific details.

Storage & Handling

Keep from freezing. Primcote® binder must be maintained above 35F (2C) to prevent the silica from precipitating irreversibly and making the product unsuitable for use.

Binder stored in transparent or translucent containers should be sheltered from direct sunlight. Shelf life is one year from date (MMDDYY) in batch lot number on label. Rotate stock to maximize shelf life.

Typical Properties

Base composition	Colloidal silica
Other composition	Proprietary
Total solids content (incl. SiO_2)	30% by weight
Particle size	10 nm
pH @ 25C	10.6
Specific gravity	1.18
Weight/Volume	9.85 lbs/gal (1.18 kg/l)
Viscosity @ 25C	10 cps
Na_2O content	0.48% by weight
Particle charge	Negative
Color with ReDip™ indicator	Greenish yellow
Color without ReDip indicator	Milky White

Contact Us

For product application support or procurement assistance, contact Ransom & Randolph at:

US TOLL FREE: (800)800-7496
US Phone: (419)865-9497
US Fax: (419)865-9997
EU Phone: (44) 0208-805-4200

Additional information is available on-line at www.ransom-randolph.com

Primcote Slurry Worksheet - English Measure

Rev. 10/31/08

A	**TANK CALCULATION**	
A1	Tank Diameter (inches)	12.00
A2	Slurry Depth (inches)	20.40
A3	Volume (gallons)	9.99
B	**SLURRY CONTROL TARGET VALUES**	
B1	Binder Solids (Recommended target 29.3-30.3)	29.80
B2	Refractory Solids (Recommended target 72-74)	73.00
C	**SLURRY TEST RESULTS**	
C1	Slurry Density (R3 at right or direct input)	1.596
C2	Total Solids (Q4 at right or direct input)	72.56
C3	Specific Gravity (S3 at right or direct input)	1.155
C4	Binder Solids	26.00
D	**CURRENT SLURRY MAKEUP**	
D1	Total Weight of Slurry	132.89
D2	Weight % of Water	27.44
D3	Weight % of Binder	37.08
D4	Weight of Centrifuged Binder	49.28
D5	Weight % of Binder	37.08
D6	Weight of Binder	49.28
D7	Weight % of Refractory	62.92
E	**WATER ADDITION**	
E1	Binder Solids Difference	-3.80
E2	Water Addition (pounds)	0.00
E3	Adjusted Weight of Slurry	132.89
E4	Adjusted Weight of Binder	49.28
E5	Adjusted Weight % of Binder	37.08
E6	Adjusted Weight % of Refractory	62.92
F	**BINDER ADDITION**	
F2	% Difference	0.86
F3	Binder Addition (pounds)	0.00
G	**REFRACTORY ADDITION**	
G1	% Difference	1.37
G2	Refractory Addition (pounds)	49.62

Q.	**Total Solids Determination**	
Q1	PAN WT (grams)	0.44
Q2	WET WT (grams)	10.17
Q3	DRY WT (grams)	7.5
Q4	Calculated Total Solids	72.56
R.	**Slurry Density Determination**	
R1	100 ML CYLINDER (grams)	155
R2	100 ML + SLURRY (grams)	314.61
R3	Calculated Slurry Density	1.596
S.	**Specific Gravity Calculation**	
S1	10 ML FLASK (grams)	9.45
S2	10 ML + BINDER (grams)	21.00
S3	Calculated Specific Gravity	1.155

Property	Target		Actual
	Lower	Upper	
Binder Solids	29.30	30.30	26.00
Refractory Solids	72.00	74.00	62.92

INSTRUCTIONS:

1. Enter the target binder and refractory solids into section B.
2. Manually enter all data in RED if you want the program to calculate the values OR directly input the required values in BLUE in Section C.
3. Enter the slurry and tank dimensions into Section A.
4. If additions are required, they appear in boxed fields in sections E, F, and G.

Primcote® Slurry Binder Solids Chart

Specific Gravity	Binder Solids	Specific Gravity	Binder Solids	Specific Gravity	Binder Solids
1.130	22.1	1.161	27.0	1.192	31.8
1.131	22.3	1.162	27.1	1.193	31.9
1.132	22.5	1.163	27.3	1.194	32.1
1.133	22.6	1.164	27.4	1.195	32.3
1.134	22.8	1.165	27.6	1.196	32.4
1.135	22.9	1.166	27.7	1.197	32.6
1.136	23.1	1.167	27.9	1.198	32.7
1.137	23.2	1.168	28.1	1.199	32.9
1.138	23.4	1.169	28.2	1.200	33.0
1.139	23.5	1.170	28.4	1.201	33.2
1.140	23.7	1.171	28.5	1.202	33.3
1.141	23.9	1.172	28.7	1.203	33.5
1.142	24.0	1.173	28.8	1.204	33.7
1.143	24.2	1.174	29.0	1.205	33.8
1.144	24.3	1.175	29.1	1.206	34.0
1.145	24.5	1.176	29.3	1.207	34.1
1.146	24.6	1.177	29.5	1.208	34.3
1.147	24.8	1.178	29.6	1.209	34.4
1.148	24.9	1.179	29.8	1.210	34.6
1.149	25.1	1.180	29.9	1.211	34.7
1.150	25.3	1.181	30.1	1.212	34.9
1.151	25.4	1.182	30.2	1.213	35.1
1.152	25.6	1.183	30.4	1.214	35.2
1.153	25.7	1.184	30.6	1.215	35.4
1.154	25.9	1.185	30.7	1.216	35.5
1.155	26.0	1.186	30.9	1.217	35.7
1.156	26.2	1.187	31.0	1.218	35.8
1.157	26.3	1.188	31.2	1.219	36.0
1.158	26.5	1.189	31.3	1.220	36.1
1.159	26.7	1.190	31.5		
1.160	268	1.191	31.6		

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