NEW & IMPROVED
DELUXCOTE® CONCENTRATE APPLICATION INSTRUCTIONS
October 2002

DELUXCOTE binder is an innovative colloidal silica binder that combines strength, flexibility and thickness to create ceramic shell molds with fewer coats compared to specialty and standard colloidal silica binders. The unique properties of this binder allow for application parameters similar to existing specialty binder systems while operating at higher viscosities. At these viscosities, and due to its design, the slurry coats go on thicker yet wet the part geometry and drain with ease. The strength and thickness is increased coat-to-coat resulting in a shell that can withstand the dewax and casting process in fewer coats.

DELUXCOTE binder is designed to give the investment caster numerous process and economic benefits including:

- Fewer dips per shell
- Less time required to build a shell, faster throughput
- Better crack resistance, even with fewer coats
- Excellent wetting & draining properties
- Higher green strength
- Dry times similar to existing specialty binders
- Reduced material consumption

The actual benefits obtained by each foundry may vary depending on the particular foundry application and the critical process parameters that are targeted by each foundry.

The New & Improved version of DELUXCOTE binder concentrate offers all of the benefits listed above and more.

The New & Improved version wets into a slurry easier and can provide additional green and hot strength. The wetting properties of the New & Improved material are also better than the standard version of DELUXCOTE concentrate.

Because less New & Improved DELUXCOTE binder slurry is used in building a shell (as compared to the original DELUXCOTE slurry), the material provides new economic benefits to the caster. New & Improved DELUXCOTE slurry lowers slurry costs as a result and adds increased value to the foundry.

TYPICAL SLURRY FORMULATIONS

Due to the unique nature of the product, the formulation implemented will vary from foundry to foundry. This flexibility allows the foundry to obtain the maximum number of benefits from DELUXCOTE binder.

For specific slurry formulations please contact our technical department at 1-800-800-7496 to discuss your specific application and to obtain the proper formulation to fit your needs.

DELUXCOTE Concentrate Mixing

When full containers of concentrate are used at one time, remixing is not necessary. When less than full containers are used, the material must be remixed as follows:

1. Open concentrate bucket by either removing pull-tab that runs the circumference of the rim or by cutting the tabs.
2. Inspect material for solid/liquid separation.
3. If separation is seen simply blend material with a paddle, spoon or other stirring tool until uniform.

Making Slurry from Concentrate (MUST be done with a prop mixer)

1. Contact the R&R technical department for specific formulation for your application.
2. Weigh the portions of each component for best accuracy.
3. Add Nyacol® 830 colloidal silica and water to the mixing tank and turn on mixer when the prop is covered.
4. Add full containers or well-mixed DELUXCOTE Concentrate material to the tank.
5. Tightly seal the bucket of DELUXCOTE concentrate when done.
6. Allow the concentrate time to mix in, this time will vary depending upon the amount of concentrate added and the mixing equipment. Typical time should be 1-5 minutes.
7. When all components are well mixed, begin adding refractory to the slurry as required.
8. It is suggested that the mixer be shut off periodically for 10-30 seconds to allow air to escape the slurry while adding refractory, this will speed the slurry stabilization process.

APPLICATION RECOMMENDATIONS

A. If not using a full package of the concentrate, REMIX BEFORE USING. This will insure material uniformity.

B. When making a new slurry or additions to an existing slurry WEIGH all materials.

C. Properly controlled, a DELUXCOTE binder slurry can be expected to last one year or more.

D. No water is required when making a new slurry, BUT IT IS NECESSARY TO REGULARLY REPLACE WATER LOST TO EVAPORATION.

E. New and makeup slurries MUST BE PREPARED WITH A PROPELLER MIXER, not in a rotating tank. This insures proper dispersion of the refractory particles. The propeller mixer must be of adequate HP and RPM. After all refractory is mixed in, it is suggested that the prop mixer should be controlled by a timer that is alternately on and off 5 minutes. Excessive mixing action can introduce air into the slurry and cause erratic viscosity and/or bubbles in the slurry coat.

F. When making up a new slurry, the viscosity can be increased by adding more refractory and decreased by adding more colloidal silica binder. As with any conventional colloidal silica slurries, a new slurry must be stabilized before it is used in production. The slurry is considered to be stabilized if there is no more than a one second change in Zahn cup reading when measured after two hour intervals. Viscosity measures should be taken with a #5 Zahn Signature Series cup.

G. SLURRY VISCOSITY SHOULD BE CHECKED AT LEAST AT THE BEGINNING OF EACH OPERATING SHIFT. 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.

H. Slurry density should be checked after viscosity adjustments are made and the slurry is stabilized. The slurry density should be maintained +/- 0.02 g/ml from the density of the slurry when originally made up. If slurry density deviates out of this range, then a silica solids content and a gelation determination test should be performed.

I. Uncontrolled binder solids cause weak shells. A binder solids content check should be done at least daily. After extended, repeatable experience with water additions to correct viscosity without a change in binder solids, the binder solids content check can be made every two or three days.

J. The pH of the binder should be checked weekly with a pH meter. It is important to note that the pH reading should be taken on a sample that has been separated from the slurry by a centrifuge. Normally the pH of your slurry binder will not vary much. If the slurry pH falls outside the acceptable range, 9.25-10.70, a gelation determination test should be performed to determine the stability of the slurry.

K. Refractory solids should be checked weekly to maintain refractory/binder ratio.

L. It is best to maintain the slurry temperature within a 5F (3C) operating range and not more than 10F (6C) above ambient temperature, as with conventional colloidal silica slurries.

M. A detailed slurry log of refractory, binder, water additions and other checks, should be maintained.

N. The drying room environment affects all ceramic shell systems. Lowering relative humidity (10-50%) can reduce shell-drying time. Substantial increases in airflow (250-400fpm, 2.0-3.0 m/s) can provide significant reduction in drying time. Temperature should be held constant to avoid shell cracking caused by pattern expansion or contraction.

O. Slurry tanks, props, slurry test tools and other equipment or containers should always be rinsed well before the DELUXCOTE binder material dries on the surface and becomes difficult to remove.

P. When using an autoclave, it is required that 80 psi (5.5 bars) dry steam pressure be achieved in 10 seconds or less. The autoclave should take approximately 2 minutes to depressurize.

Q. In most cases, the final dry time will be 12-16 hours. Some refractories or refractory blends may require a longer final dry time.

R. A worksheet for use during slurry control calculations is included in these instructions and can be used to help determine required additions to the slurry. Contact R&R for more copies if required.

S. Primcote® binder provides the greatest benefits available for the primary shell coats.

T. R&R can provide Microsoft® Excel spreadsheets for slurry formulation and control as requested.

SLURRY DENSITY DETERMINATION

The following method can be used to check slurry density:

1. Pre-weigh a 100 ml graduated cylinder on a scale sensitive to 0.1 gram.
2. Fill the cylinder with exactly 100-ml of well-mixed slurry and re-weigh.
3. Subtract the empty graduated cylinder weight from the filled weight. Divide the difference by 100 to obtain the density in g/cc.

SLURRY BINDER SOLIDS CONTENT DETERMINATION & ADJUSTMENT

To properly monitor and control the slurry binder solids content of the DELUXCOTE binder slurry, the following procedures can be performed. The backup slurry binder should be:

Binder Solids Control Range:
29.0 to 32.0

Binder Specific Gravity:
1.138-1.160

NOTE: This is a general binder solids range for this product. Consult with the R&R technical department to confirm your range.

Determination Method

1. Collect four 50-ml centrifuge tubes of slurry and centrifuge for approximately 30 minutes or more at 3000-3500 RPM.
2. After centrifuging there will be three distinct layers in the centrifuge tube, the solid refractory layer on the bottom, a liquid center layer and a thin organic layer on the top. Decant the pourable, portion (not refractory) from the tube into a clean container that can be sealed. STIR THIS PORTION WELL.
3. If the centrifuged sample is not used within 20 minutes after the centrifuge has stopped it should be centrifuged an additional 5 minutes before proceeding.
4. Transfer a sample with a pipette or an eyedropper into a pre-weighed, 10-ml VOLUMETRIC FLASK, and not a graduated cylinder.
5. Weigh the flask and sample together on a scale accurate to 0.01 grams.
6. After subtracting the flask weight, calculate the specific gravity by dividing the sample weight by 10.
7. Using the determined specific gravity and the chart on the inserted page, locate the percent of binder solids content. DO NOT USE ANY OTHER CHART.

ADJUSTMENTS
(Refer to attached worksheet for assistance)

For calculation example purposes, the binder solids target is 29.8. Your binder solids target may be different. Consult the R&R technical department with questions.

A. For a given weight of binder, the following chart outlines the amount of water that should be added for each percentage point that the binder solids is above 29.8%. To determine the binder weight in your slurry, follow these steps:

1a. Multiply slurry volume (gal) by slurry density (g/ml), and then multiply by 8.337 to get weight of slurry in pounds.

1b. For metric system, multiply slurry volume (L) by slurry density (g/ml) to get weight in kilograms.

2. Subtract the percent refractory solids (calculated below) from 100 to determine % binder.
3. Multiply slurry weight (kg or lbs.) by percent binder to determine weight of binder.
4. Using the weight of binder determined, use the following factor to determine water addition. The chart allows you to select the units used to add the required water. For example if binder solids is found to be 31.0 you are 1.2% (31.0-29.8) over the target. If you have determined you have 25 pounds of binder you have a factor of 2.5 (25/10). Using these number the chart the following water adds would be made: 1.2x2.5x152=456 ml water ***or*** 1.2x2.5x5=15 fluid oz. water ***or*** 1.2x2.5x0.34=1.02 pound water.

Water Addition Required/Percentage Point

Weight of Binder	Milliliter water add	Fluid oz. water add	Weight water add
10 pounds	152	5	0.34 pounds
1 kilogram	34	1	34.0 grams

These adjustments are very close to being linear.

B. Below the normal range, the slurry is substandard and can cause weak shells. Evaporation should be allowed to remove excess water and bring the slurry binder solids content back into the normal range. The low binder solids content level is usually the result of too much water being added to the slurry.

REFRACTORY SOLIDS
DETERMINATION & ADJUSTMENTS

The following procedure should be used to check that the refractory solids are maintained in the recommended range (+/- 1.0% from original formula in most cases unless noted by R&R Technical Department).

1. Pre-weigh a metal weighing pan on scale accurate to 0.1 gram.
2. Place approximately 10 grams of well-mixed slurry in the pan. Subtract the pan weight and record the sample weight.
3. Dry in oven at 350F (180C) for one hour.
4. Once dry, re-weigh sample: subtract the pan weight and record dry sample weight.
5. Calculate total solids by taking the weight in Step 4, the dry sample weight, and divide by weight in Step 2, the wet sample weight.
5. Calculate % water in the slurry by subtracting total solids (Step 5) from 1.0, then multiply by 100.'

6. Calculate the % water in the binder by subtracting the % binder solids measured from 100.

7. Calculate the refractory solids by dividing the difference in Step 6, the percentage of water in the slurry, by the difference in Step 7, the percentage of water in the binder, and then by 0.98. Subtract the result from 1.0, then multiply by 100.

ADJUSTMENTS
(Refer to attached worksheet for assistance)

When refractory solids are low, divide the difference of 100 minus % refractory solids present, by the % binder desired, subtract 1.0 and multiply by the weight of slurry to get the weight of refractory needed for adjustment.

The weight, in kilograms, of the slurry is calculated by multiplying the slurry density (g/cc) by the volume of slurry (liters).

The weight, in pounds, of the slurry is calculated by multiplying the slurry density (g/cc) by the volume of slurry (gallons), then multiplying by 8.34.

When refractory solids are high, divide the % refractory solids present by the % refractory solids desired, subtract 1 and multiply by weight of slurry to get weight of liquid needed for adjustment.

When correcting the high refractory solids, the liquid that is added is as follows:

1. When silica solids and refractory solids are BOTH high add the required amount of WATER to bring the silica solids in control. Retest the silica solids and determine the new refractory solids.

2. When silica solids are in control and ONLY refractory solids are high, all of the liquid required to adjust the high refractory solids should be DELUXCOTE BINDER.

GELATION DETERMINATION

The following method can be used to determine the potential for slurry gelation. It is important that the gelation test be conducted on a sample that has been adjusted and is in specification. Otherwise a false positive indication is possible.

1. Prepare a sample of binder from the slurry using the Binder Solids Content Determination Method (Steps 1-3) NOTE: the sample used for the Binder Solids Content Determination can be subsequently used to perform the gelation test.

2. Pour 10 to 20 ml of binder into a sealable container capable of withstanding 150F (65C).

3. Place the sealed container in a temperature controlled oven at 140 +/- 5F (60 +/- 3C) for 16-24 hours.

4. Observe the viscosity of the liquid. If the viscosity has increased, slurry life will be short. If the viscosity is very high or gelled, the slurry should be discarded to avoid producing poor quality shells.

R&R®

DENTSPLY®

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TYPICAL PROPERTIES OF MIXED BINDER

Base Composition	Colloidal Silica
Other composition	Proprietary
Total Solids Content (incl. SiO_2)	31.1%/wt
Particle Size	10 nm
pH @ 25C	10.6
Specific Gravity	1.144
Weight/Volume	9.54 lbs./gal (1.14 kg/l)
Viscosity @25C	<50 cps
Na_2O content	0.41%/wt
Particle Charge	Negative
Color	White

STORAGE & HANDLING

Keep from freezing. DELUXCOTE concentrate 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. For information on economical remixing equipment as well as detailed mixing instructions contact R&R's Customer Service department at 1-800-800-7496.

SAFETY

OSHA approved respiratory protection should always be worn to avoid inhalation of respirable silica dust, which results in irreversible lung disease, silicosis. Such exposure includes slurry makeup, casting, knockout and cleanup. The DELUXCOTE concentrate material is completely non-flammable. Refer to MSDS for specific details.

TECHNICAL SUPPORT

R&R's technical expertise and support capabilities are unmatched by other suppliers in the precision investment casting industry. Many investment casters depend on R&R's technical support and Product & Application laboratory. R&R also has an R&D foundry dedicated solely to developing and

testing products for precision investment casting applications. We invite you to call us, toll free.

PACKAGE/DISTRIBUTION CENTERS

Call our Customer Service department for package availability and for the distribution center closest to you.

CALL (800)-800-7496 (USA) OR (419)-865-9497

New & Improved Deluxcote® concentrate
Specific Gravity vs. % Solids Chart

SPECIFIC GRAVITY	% SOLIDS	SPECIFIC GRAVITY	% SOLIDS	SPECIFIC GRAVITY	% SOLIDS	SPECIFIC GRAVITY	% SOLIDS
1.180	34.66	1.164	32.48	1.148	30.29	1.132	28.11
1.179	34.52	1.163	32.34	1.147	30.15	1.131	27.97
1.178	34.39	1.162	32.20	1.146	30.02	1.130	27.83
1.177	34.25	1.161	32.07	1.145	29.88	1.129	27.70
1.176	34.11	1.160	31.93	1.144	29.74	1.128	27.56
1.175	33.98	1.159	31.79	1.143	29.61	1.127	27.42
1.174	33.84	1.158	31.66	1.142	29.47	1.126	27.29
1.173	33.70	1.157	31.52	1.141	29.33	1.125	27.15
1.172	33.57	1.156	31.38	1.140	29.20	1.124	27.01
1.171	33.43	1.155	31.25	1.139	29.06	1.123	26.88
1.170	33.30	1.154	31.11	1.138	28.93	1.122	26.74
1.169	33.16	1.153	30.97	1.137	28.79	1.121	26.60
1.168	33.02	1.152	30.84	1.136	28.65	1.120	26.47
1.167	32.89	1.151	30.70	1.135	28.52	1.119	26.33
1.166	32.75	1.150	30.56	1.134	28.38	1.118	26.19
1.165	32.61	1.149	30.43	1.133	28.24	1.117	26.06

DELUXCOTE® Binder Slurry Worksheet – English Units

A Tank Calculation

A1. Tank Diameter……...…… _____ inch

A2. Slurry Depth ……..…… _____ inch

A3. Volume = (A1 × A1 × A2 × 3.14) ÷ 923.64 ……..…..…. _____ gallon

B Slurry Test Results

B1. Slurry Density ……..…… _____ g/cm^3

B2. Total Solids (from moisture balance or drying) …….. _____ %

B3. Specific Gravity of Centrifuged Binder ……..…… _____

B4. Percent Solids of Centrifuged Binder (based on B3 and the chart) …….. _____ %

C Current Slurry Makeup

C1. Total Weight of Slurry = B1 × A3 × 8.337 ……...……... _____ lb

C2. Weight % of Water = 100 – B2 ……..... _____ %

C3. Weight % of Centrifuged Binder = [C2 ÷ (100 – B4)] × 100 ……. _____ %

C4. Weight of Centrifuged Binder = (C1 × C3) ÷ 100 …….……. _____ lb

C5. Weight % of Binder = C3 ÷ 0.982 ……...…… _____ %

C6. Weight of Binder = (C1 × C5) ÷ 100 ……..……. _____ lb

C7. Weight % of Refractory = 100 – C5 …… _____ %

D Water Addition

D1. % Binder Solids Desired ……..... _____ %

D2. Binder Solid Difference = B4 – D1 …….…….. _____ %

D3. Water Addition = (C4 × D2) ÷ D1, (= 0 & skip to E section, if D2 ≤ 0) _____ lb

D4. Adjusted Weight of Slurry = C1 + D3 …….…… _____ lb

D5. Adjusted Weight of Binder = C6 + D3 …….…... _____ lb

D6. Adjusted Weight % of Binder = (D5 ÷ D4) × 100 ……... _____ %

D7. Adjusted Weight % of Refractory = 100 – D6 …….… _____ %

E Binder Addition

E1. % Refractory Loading Desired ……..... _____ %

E2. If D7 (or C7, if no water addition) < E1, skip to F section for refractory addition

E3. D7 (or C7, if no water addition) ÷ E1 ……..…… _____

E4. Binder Addition = (E3 - 1) × D4 (or C1, if no water addition) …… _____ lb

F Refractory Addition

F1. D6 (or C5, if no water addition) ÷ (100 – E1) ……. _____

F2. Refractory Addition = (F1 – 1) × D4 (or C1, if no water addition)……. _____ lb

DELUXCOTE® Binder Slurry Worksheet – Metric Units

A Tank Calculation

A1. Tank Diameter……...…… _____ cm

A2. Slurry Depth ……...…… _____ cm

A3. Volume = (A1 × A1 × A2 × 3.14) ÷ 4000…….…..…..…. _____ liter

B Slurry Test Results

B1. Slurry Density ……...…… _____ g/cm^3

B2. Total Solids (from moisture balance or drying) ……..……. _____ %

B3. Specific Gravity of Centrifuged Binder ……..…… _____

B4. Percent Solids of Centrifuged Binder (based on B3 and the chart) ……. _____ %

C Current Slurry Makeup

C1. Total Weight of Slurry = B1 × A3 ……..……...……... _____ kg

C2. Weight % of Water = 100 – B2 ……..... _____ %

C3. Weight % of Centrifuged Binder = [C2 ÷ (100 – B4)] × 100 ……. _____ %

C4. Weight of Centrifuged Binder = (C1 × C3) ÷ 100 …….……. _____ kg

C5. Weight % of Binder = C3 ÷ 0.982 ……...…… _____ %

C6. Weight of Binder = (C1 × C5) ÷ 100 ……..……. _____ kg

C7. Weight % of Refractory = 100 – C5 …… _____ %

D Water Addition

D1. % Binder Solids Desired ……..... _____ %

D2. Binder Solid Difference = B4 – D1 …….…….. _____ %

D3. Water Addition = (C4 × D2) ÷ D1, (= 0 & skip to E section, if D2 ≤ 0) _____ kg

D4. Adjusted Weight of Slurry = C1 + D3 …….…… _____ kg

D5. Adjusted Weight of Binder = C6 + D3 …….……... _____ kg

D6. Adjusted Weight % of Binder = (D5 ÷ D4) × 100 ……... _____ %

D7. Adjusted Weight % of Refractory = 100 – D6 …….… _____ %

E Binder Addition

E1. % Refractory Loading Desired ……..... _____ %

E2. If D7 (or C7, if no water addition) < E1, skip to F section for refractory addition

E3. D7 (or C7, if no water addition) ÷ E1 ……..…… _____

E4. Binder Addition = (E3 - 1) × D4 (or C1, if no water addition) …… _____ kg

F Refractory Addition

F1. D6 (or C5, if no water addition) ÷ (100 – E1) ……. _____

F2. Refractory Addition = (F1 – 1) × D4 (or C1, if no water addition)……. _____ kg