# Basics of Slip Casting – Aardvark Clay Cone 06 Casting Slip

**INTRODUCTION**

In theory, slip casting is a simple procedure, but in practice contains some complex variables. These include the raw materials, water, the shape to be cast, mold design, and the type and amount of deflocculant used. Following a few rules and employing accurate testing procedures will go a long way in helping you achieve good slip casting results.

**MATERIALS & CHEMICALS USED IN CONE 06 CASTING SLIP**

Talc is a hydrophobic, non-plastic filler that fires white and controls thermal expansion in the fired bisque which results in proper glaze fit. Ball clays are plastic or elastic materials that come in a variety of casting grades. They are used to suspend non-plastic materials and add green strength to the cast. Ball clays higher in organics tend to require a higher percentage of deflocculant to make the slip fluid.

Deflocculants are electrolytes that cause ball clay particles to become electrically charged and thus repel each other. The degree to which this repelling occurs is an important factor in creating a good casting slip. A good casting slip should contain no more than 32% water by weight and this is achieved through the use of deflocculants. Sodium Silicate (N grade) is a powerful liquid deflocculant that should be diluted 50/50 with water before use. It can be used in combination with Soda Ash. Soda Ash dissolves lignite in the clay and aids the Sodium Silicate in its ability to deflocculate ball clays. We have not used Soda Ash in years and it is not included in our formula. Darvan #7 is a dispersing agent that may be used as a substitute for Sodium Silicate or can be used in addition to the Sodium Silicate to fine tune your slip with less fear of over deflocculation. Using Soda Ash with Darvan #7 is not recommended.
Barium Carbonate should always be used as it neutralizes soluble salts (magnesium, potassium, and sodium sulfates) that cause efflorescence (scumming). The carbonate from the Barium will react with the soluble salts (sulfates) resulting in insoluble Barium Sulfate. The soluble salts (sulfates) captured by the Barium become insoluble chlorides of sodium, potassium, magnesium and will not migrate to the surface of the clay wall to effloresce (scum). Efflorescence can cause a barrier between the clay and under-glaze and/or glaze, which can result in shivering and hard areas. Use caution when handling as ***Barium Carbonate is toxic in raw form*****.** Ingestion of as little as 40 grams can cause death. Keep Barium Carbonate out of reach of children and animals.

Water is often overlooked when mixing slip. Chemicals such as chlorine are added to water supplies by municipal water companies. These chemicals may make it necessary to use slightly more or less deflocculant. Changes in the water can occur whenever the water companies make seasonal adjustments to their water supply. It is important to carefully measure the water and raw materials each time you mix a batch of slip.

## Mixing Instructions for a 10 gallon batch

| | |
|---|---|
| **Aardvark Clay Cone 06 Casting Slip** | **100 lbs.** |
| **Barium Carbonate** | **15 grams - dry weight** |
| **Sodium Silicate** (pure, not 50/50 solution) | **220 grams - liquid weight** |
| **Water** | **5½ gallons** |

1) Wear a NIOSH/OSHA approved respirator (3M #8710 / Gerson #1730) with a N-95 rating.
2) Pour 5½ gallons of water into the slip mixer.
3) Add 15 grams of Barium Carbonate. Mix for a minimum of 5 minutes.
4) Add 90% of your Sodium Silicate. Mix for additional 5 minutes.
5) Slowly add dry slip to the water. Work any dry, unmixed slip from the side walls of the mixer into the liquid slip.
6) After 30 minutes, observe the mixing action of the slip. Additional Sodium Silicate can be added to bring the slip close to its proper viscosity. This is a critical stage since adding too much Sodium Silicate will over-deflocculate the slip and cause a number of casting problems. The slip should appear a little thick at this stage.
7) Mix for a minimum of 1 hour and shut down the mixer. Let slip particles “wet” over night.
8) The next day, the slip particles will have fully wetted. It’s now time to fine tune the slip with Sodium Silicate solution or Darvan #7. “Eye balling” the slip is not adequate. It must be tested properly.
   Sodium Silicate solution is half water / half Sodium Silicate.
9) Add additional Sodium Silicate solution or Darvan #7 until your tests show the slip is ready. Add these additions incrementally. Never add water to adjust slip flow if the specific gravity is within limits.
10) Screen slip through a 30 mesh sieve. Up to 20 grams of Magnesium Sulfate in a water solution or very small additions of vinegar can be added to the slip to increase the wall thickness of the cast.

# Testing Procedures

**Step 1. WEIGHING SLIP TO FIND THE SPECIFIC GRAVITY**

1) Using a gram scale, place a 250 ml. graduated cylinder on the scale and "zero-out" the scale so you are not weighing the graduated cylinder, only slip and water.
2) Fill the graduated cylinder with slip to the 250 ml. mark, and weigh and record the weight ( 437 grams? ). Empty and clean.
3) Fill the graduated cylinder with water to the 250 ml. mark, weigh and record the weight ( 250 grams ). One gram of water equals one ml. or cc by volume.
4) Divide the weight of the slip by the weight of the water (437÷250 = 1.75). This is the specific gravity. Your slip should be between 1.75 and 1.80. If the answer is above 1.80, add water. If the answer is below 1.75, then add a small amount of dry slip.

Specific gravity can also be read with a hydrometer. Hydrometers are indicators only. They are not as accurate as you performing the above test. A dry, clean hydrometer is held between the index finger and thumb, slowly lowered into the slip, and released. When settled, the reading on the hydrometer scale should be around 1.75.

**Step 2. VISCOSITY OR FLOW TEST**

To determine the proper amount of deflocculant, you must measure the viscosity/flow of the slip. The viscosity/flow test measures the time for a set volume of slip to flow out of a container. A viscometer that measures slip flow over a period of a minute or longer is recommended. An alternative is to construct your own. Use a 10" piece of 2" diameter PVC pipe. Connect a cap with a 5/32" hole drilled in the center. Turn the container over so the hole is facing downward, place your finger over the hole, fill the container to the rim with slip, and then let the slip drain into a 250 ml. graduated cylinder. Time the flow from when you remove your finger until the slip fills the graduated cylinder to the 250 mark. The time should be about 25 seconds for good slip.

**Step 3. CASTING TEST**

A casting test is more informal but the best slip casting indicator. Use a two piece mold or something similar to what is being cast. Use the same mold each time for future slip comparisons. Note how long it takes to cast, drain, and remove your casting. Note characteristics such as softness, brittleness, tears, sloping of slip in the mold reservoir, etc. Over time you will quickly gauge the quality of your slip from your past observations. Casting rate (thickness over a set period of time) can be measured by weighing the cast piece on a gram scale. For small pieces, cast for 20 minutes, drain for 20 minutes, retrieve cast, trim reservoir, and weigh the cast. Keep good records for future use.

# Trouble Shooting

| FAULT | DESCRIPTION | CAUSE | REMEDY |
|---|---|---|---|
| Pinholing | Small holes beneath the surface | Fluidity too low | Increase deflocculant |
| | | Trapping air when pouring or mixing | Tap mold to cause air bubbles to rise to top. Allow slip to stand overnight. |
| Wreathing | Horizontal ridges on the mold side of the casting where the slip “skips” along the surface of a mold | Organic ribbons forming between slip particles from over deflocculantion | Decrease deflocculant ratio by adding water and dry slip |
| Brittle Casting | Hard, brittle castings difficult to cut or clean | Over deflocculation | Decrease deflocculant ratio by adding water and dry slip |
| Cracking | Small cracks where the handles join the piece | Over deflocculation | Decrease deflocculant ratio by adding water and dry slip |
| | | When an add on is is dryer/wetter than the main piece | Make sure both pieces are equally moist |
| | | Specific gravity too low | Reduce water to achieve 1.75-1.80 |
| Poor Draining | Slip does not drain from narrow sections | Fluidity too low | Increase deflocculant |
| | | Specific gravity too high (above 1.80) | Adjust water/dry slip ratio to a specific gravity of 1.75 |
| Slow Casting | Casting time too long | Over deflocculation | Decrease deflocculant ratio by adding water and dry slip |
| | | Specific gravity too low | Decrease water amount |
| Thixotropic | Slip appears jelly-like | Over deflocculation or under deflocculation | Adjust deflocculation |