

How to make and adjust casting slip

Making good slip is the first and most vital step in a successful slip casting operation. Although there are those who will say they have been using the same Dixie Cup for the last ten years to measure Sodium Silicate, and a nail on a wooden barrel for a water marker, this approach leaves far too much room for error.

Accurate measurements of Viscosity and Specific Gravity are important. It doesn't take a ceramic engineer to make a good quality casting slip, but slip mixing is a chemical process that is affected by even the slightest changes in temperature, humidity and the chlorine and chemicals that are added to water supplies. Changes in conditions such as weather and water can sometimes affect the mixing formula, but if you adhere to the following procedures, you will consistently make good slip.

It is common to experience significant variations in the amount of deflocculant required from one clay body to another. Low-fire, talc bodies, for instance, require considerably more deflocculant than Cone 5 porcelain bodies. It should be noted that our suggestions are based upon average climatic and water conditions in our laboratory in Southern California. Adjustments may be necessary to fit your climate, water and general studio or plant conditions. Also, for best results, make your slip 24 hours before using it for casting.

Equipment & Chemicals Necessary for Slipmaking

Slip Mixer

With a motor and blades which are capable of properly mixing your batch of slip.

Gram Scale

With 500g attachment weight. A postage scale is not accurate enough.

Viscometer

The principal quality control tool for slip. It is used to determine Specific Gravity, the ratio of clay to water in the slip, and to measure Viscosity, the property of flow.

Liquid Ounce Measuring Cup

Sodium Silicate, for instance, must be measured by the liquid ounce, not by weighing it on a scale. 4 ounces of Sodium Silicate, measured by volume, weighs approximately 5 ounces on a scale.

Respirator Mask

NIOSH approved.

Sieve or a Shaker Screen

A Talisman Glaze Sieve (TM-363 in this catalog) is an invaluable aid in screening your slip. You simply turn the handle and the slip is forced through the screen. 60 mesh or finer recommended.

Clock or Stopwatch

To measure seconds for the Viscosity test.

Liquid Ounce Measuring Cup

Sodium Silicate, for instance, must be measured by the liquid ounce, not by weighing it on a scale. 4 ounces of Sodium Silicate, measured by volume, weighs approximately 5 ounces on a scale.

Sodium Silicate (N Brand)

Sodium Silicate is a chemical used to deflocculate casting slip. Too much Sodium Silicate causes overdeflocculation. (See the section on Over-Deflocculation.) Sodium Silicate may be stored for extended periods in tightly closed plastic containers. (Aluminum, galvanized iron or zinc containers SHOULD NOT be used.)

- NEVER ADD UNDILUTED SODIUM SILICATE TO THE SLIP BATCH.
- NEVER ADD ENTIRE PORTION OF SODIUM SILICATE TO THE BATCH ALL AT ONE TIME. ADD ONLY IN SMALL AMOUNTS.

Soda Ash

Soda Ash works to dissolve lignite in clay. It works in combination with Sodium Silicate to aid in deflocculation. The correct combination of the two will give proper casting qualities, however, if only Soda Ash is used, your clay will become sticky. If Soda Ash is not stored in tightly closed containers, a chemical change occurs and it becomes Sodium Bicarbonate (Baking Soda). If this occurs it will then act as a flocculant (thickener) instead of as a deflocculant.

Barium Carbonate (Toxic in raw form)

Barium Carbonate neutralizes (1) sulphates present in the clay or in the water and (2) sulphates leached from molds used in casting.

Dispersal (Darvan)

Dispersal is an organic deflocculant that can be used with less fear of over-deflocculation. It is especially effective in hard water areas. Darvan 7 is recommended for most applications, Darvan 811 is best for red slips.

- DO NOT ALLOW DISPERSAL TO FREEZE.

Mixing and Formula Procedures

You will find that different proportions of materials and chemicals will alter the performance of your slip, making it more or less desirable in your process.

Therefore, we do not provide precise amounts of the ingredients in our formulas. Instead, a starting minimum amount is given. We recommend that you begin with these amounts and, if adjustments are needed, slowly and carefully add additional quantities.

A formula using 100 lbs. of dry clay blend will yield 10 gallons of slip. Remember, start with the minimum amounts shown below.

- **Clay Blend**
100 lbs.
- **Barium Carbonate**
1/2 ounce (14.75 gr.)
- **Soda Ash**
1 ounce (23.35 grams)
- **Water**
5 gallons (19.50 liters)
- **Sodium Silicate**
2 1/2 fluid ounces. You **MUST** dilute this amount with a like amount of water. This will yield 5 ounces of diluted Sodium Silicate.

SODIUM SILICATE SHOULD ALWAYS BE DILUTED 50/50 WITH WATER BEFORE BEING ADDED TO THE BATCH.

1. Before you begin mixing, put on a good quality respirator to protect you from inhaling dust.
2. Measure water carefully and pour into the slip tank.
3. Accurately measure the minimum amount of Sodium Silicate indicated for your batch and add a like amount of water (i.e. 5 oz. Sodium Silicate + 5 oz. water) in a measuring cup. Set aside. **NEVER ADD SODIUM SILICATE FULL STRENGTH TO A BATCH OF SLIP.**
4. Accurately measure the amounts of Soda Ash and Barium Carbonate indicated for your size batch.
5. Add Barium Carbonate and Soda Ash to one quart of warm water. (Warm water aids in mixing the chemicals.)
6. Turn mixer on. Add diluted Barium Carbonate and Soda Ash (which you prepared in Step 5) to the water that is in the tank. Mix for 5 minutes.
7. While the tank is still mixing, slowly add 1/3 of the clay indicated for your size batch to the water.
8. Slowly add 1/3 of the Silicate solution (as mixed in Step 3) to the batch. **NEVER ADD PREMEASURED SODIUM SILICATE TO THE BATCH ALL AT ONE TIME. ADD ONLY IN SMALL AMOUNTS.**
9. Mix approximately ten minutes, allowing the Sodium Silicate to thin the batch, then add 1/3 more of the clay. Allow clay to mix into the batch.
10. Add 1/3 more of the Sodium Silicate solution. This will again thin the batch.
11. Mix another 10 minutes, then add the final 1/3 of your clay to the mixer.
12. Add the last 1/3 of the Sodium Silicate.
13. Let the mixer run according to the following table, or until all lumps are blended away:

100 lbs. = 2 hours 1000 lbs. = 4 hours
300 lbs. = 3 hours 2000 lbs. = 5 hours

Test Procedures

To determine if the slip is properly prepared, you need to measure two properties: Specific Gravity and Viscosity. You should measure and adjust Specific Gravity before you test and fine-tune the Viscosity. Specific Gravity can be tested after the mixing time indicated in the table above. Viscosity should be tested no sooner than 12-24 hours after the batch is mixed. This allows the clay particles time to hydrolyze, or become wet on all surfaces. If the viscosity is adjusted before hydrolyzation is complete, you are likely to over-deflocculate the slip.

Test Procedures (cont.)

Specific Gravity Test

After all lumps are blended away.

1. Remove the stopper from your viscometer and weigh the dry, empty flask.
2. Fill the flask with slip up to the 500ml mark.
3. Weigh the filled flask on your gram scale.
4. Subtract the weight of the flask from the total weight. The result will be the net weight of 500ml of slip.
5. Divide the gram weight of the slip by 500 to establish the Specific Gravity. Example: A slip weight of 875 grams \div 500 gives a Specific Gravity of 1.75. Experience will teach you which weight is most appropriate for your casting conditions, and most casting slips work best between 1.72 and 1.80 Specific Gravity.

Viscosity Test

12-24 hours after batch is mixed.

1. Fill the flask to the 500ml mark and insert the stopper.
2. Hold your finger over one hole in the stopper and turn the Viscometer upside down.
3. Release your finger from the hole and time the flow of slip until you count one second between drops. Normally the slip will flow through in 100 to 130 seconds. A fast flow time (thin slip) can lead to a slower setting time and more brittle ware. A slow flow time (thick slip) will set up faster in your molds but render ware that is less dense.
4. Tips:
 - a) If the slip weight is normal, it is highly unusual for the flow rate to be less than 100 seconds per 500ml.
 - b) If the slip weight is normal and the flow time is more than 130 seconds, you may need a little more diluted Sodium Silicate or Dispersal. Never add water - it changes the Specific Gravity.
 - c) After testing, always wash your Viscometer with cold water and store at room temperature.

Adjusting the Batch

If your Specific Gravity is too low, add more clay to the batch. Then you need to wait while the addition mixes completely through the batch. With every clay addition, you should mix the batch for the fully recommended time (i.e. 3 hours for a 300 lb. batch).

If the Specific Gravity is too high, add water. If the Viscosity is too high, add deflocculant. You need to wait just twenty minutes for these additions to mix through the batch before re-testing.

If your Specific Gravity or Viscosity are not within the recommended limits, but your slip casts well, you should not make any adjustments!

Over-deflocculation

Sodium silicate is the most common economical and powerful deflocculant. Unfortunately, it can quickly turn from your friend to your foe. Initial additions of sodium silicate serve to thin (deflocculate) the batch. However, there is a point after which sodium silicate starts to have the opposite effect, actually making the batch thicker (flocculating it). Compounding the difficulties is the fact that sodium silicate accelerates its effectiveness as it nears the point of over-deflocculation. For example, you might add one ounce to the batch three times, with little improvement in Viscosity, but the fourth addition will send the batch over the limit. That is why it is recommended to use small additions until you are familiar with slip making.

If you add sodium silicate and the slip gets thicker instead of thinner, it is over-deflocculated, and you have two options: you can try to recover the batch or throw it away. If your slip is badly over-deflocculated, it is very difficult to correct and will cost you more in time and frustration than the purchase of new slip. If the batch is slightly over deflocculated, you can bring it back with the addition of more dry material. Determining the correct amount will be trial and error, but with every clay addition, you should mix the batch for the fully recommended time (i.e. 3 hours for a 300 lb. batch).

If you believe you are close to over-deflocculation, it is time to switch from sodium silicate to dispersal. Dispersing agents such as Darvan can be added after you have added the maximum amounts of Sodium Silicate. You may add as much as 1 ounce of dispersal per 100 lbs. of dry clay without fear of over-deflocculation.