Mixing Slip, Plaster Mold Fabrication, Slip-Casting

Kimberlee Joy Roth - 2015

Porcelain Casting Slip Recipe

Grolleg	55
Minspar	45
Flint/ Silica	30
Darvan 811	35 - 45 grams
Water	45.5 lbs = 35%

Plaster to Water Ratio 10:7

1 kg Plaster to 0.7 kg Water
1.5 kg Plaster to 1.05 kg Water
2 kg Plaster to 1.4 kg Water
2.5 kg Plaster to 1.75 kg Water
3 kg Plaster to 2.1 kg Water
3.5 kg Plaster to 2.1 kg Water
4 kg Plaster to 2.8 kg Water
4.5 kg Plaster to 3.15 kg Water
5 kg Plaster to 3.5 kg Water

Mixing Casting Slip

Weight out the water and place it into a container.

Weigh out each dry ingredient into a separate container. (A 5-gallon bucket will hold 1/4 of the above recipe. I usually make a full batch in a 20-gallon plastic trashcan so I don't weigh out the Grolleg, I just add the entire bag.)

Add 35 grams of Darvan to the water.

Add the dry ingredients to the water beginning with the Grolleg then feldspar then silica. If you are using another recipe then the one above start with the kaolins then add the other clays then the feldspar then the silica. Mix the slip with a power drill fitted with a paint mixer after each material is added. Add 5-10 drops of Darvan with an eyedropper if needed after adding the Minspar and/or Silica.

Let sit at least 24 hours covered. The chemical reaction between the kaolin particles and the Darvan is a very slow reaction and takes 24 hours. This next day remix and sieve the slip through a 40-mesh screen. Add more Darvan, 3-5 drops at a time, until is at a heavy whipping cream consistency. **There should not be any bubbles suspended throughout the slip. Adding more Darvan will allow the bubbles to rise to the top.** When too much Darvan is added, the water that separates and rises to the top of the container is a dark yellow amber. Another way to know if there is too much Darvan is as the slip sits in the mold as it is being cast, a thin layer of slip will set on top of the liquid slip. To fix this add multiples of 2.5 lbs of dry with 1 lb of water until the excess Darvan is used by the clay molecules.

If you are the chemist type you can find the specific gravity of the slip by measuring the mass of a volume of slip and dividing that mass by the mass of the same exact volume of water. This ratio is the specific gravity and should be close to 1.8. If the s.g. is much higher then 1.8, say 1.95, then add a small amount of water, mix well and recalculate the s.g. Repeat this until the s.g. is close to 1.8. If you add too much water, let it evaporate or add more dry mix.

$$\text{s.g.} = \frac{\text{Mass of Volume of Slip}}{\text{Mass of Volume of Water}} \geq 1.8$$

Before I pour slip into any mold, I always sieve it to be sure I eliminate lumps. This will ensure an even wall thickness throughout the cast. This will also prevent any plaster that may have broken off your molds to get into the slip and potentially ruin work when it is firing in the kiln.

Mixing Plaster

Mixing plaster for a slip-casting mold is different then for a press mold. To insure even wall thickness throughout the cast, each part of the mold must be made with the same plaster-to-water ratio. I find that using the hump method for measuring out plaster yields unsatisfactory results, as the ratio between the different sections can vary greatly.

First, prepare your model. Mine is carved from insulating foam that's first cut out using a template and hot wire foam cutting tool. A separate form is cut out for the reservoir and held in place on top of the main form with t-pins that are pushed at an angle through the side of reservoir form into the main form. Bricks are used for added security when pouring the plaster so the form doesn't move. I place my form on top of a ¼" piece of Plexiglas and use one corner of the Plexiglas to get the cottles square. The Plexiglas protects the work surface and allows me to move the entire mold if needed.

Brush a 50/50 Murphy's Oil Soap/water solution liberally on the Plexiglas and the model, place the model on the Plexiglas, arrange the cottles and clamp the cottle boards together. Seal any seams between the boards with coils of clay to prevent plaster leaks. Also brush the Murphy's Oil Soap solution liberally onto the cottles so they release from the plaster easier.

Next, determine the volume you will be filling with the plaster/water mixture.

Volume of a rectilinear cube is Length x Width x Height.
Volume of a triangular shape is ½ x Length x Width x Height.
Volume of half a sphere is $2/3\ \pi\ \text{Radius}^3$.

Calculate the Volume in cubic inches then multiply this by 0.015.

$$\text{Mass of Plaster in Kg} = \text{Volume in inches}^3 \times 0.015$$

This will give the mass in Kilograms of plaster that are needed to fill the space. The more precise you measure the more exact the Kilogram calculation will be. Round up or down and use the chart on page one to determine the amount of water to mix with the plaster. I used to use warm water but I have found that using water that is at the same temperature as the plaster works best. The day before I am going to make a mold I fill a 5-gallon bucket of water and let it sit overnight.

Weigh out the plaster into a separate dry container using the amount called for in the ratio chart. Slowly pour the plaster into the water so as not to cause splashes. Stir with you hand. It should take less then 2 minuets to get the plaster mixed and get any clumps broken up. I pour as soon as all the clumps are out. Pour the plaster through your fingers to avoid splashes. When you have the plaster up to the level you want put your fingers into the plaster and run them gently over the surface of your model to release air bubbles, release the bubbles that may be on the Plexiglas and on the cottle board sides. I run my fingers over all the surfaces under the plaster multiple times to be sure all the air bubbles that may be trapped on the surface of the form are released. Also, remove the t-pins if used to hold separate pieces together, but the bricks can remain.

Pour excess plaster into a garbage bag, or leave in the bucket. I tip the bucket at an angle so the cured plaster is easier to remove. On the other hand, if you need to make plaster slabs then do that with the extra plaster. Plaster is drying to the skin so wear gloves or use moisturizer when you are done for the day.

Let the plaster cast set up for a few hours, until the plaster has cooled, before removing the boards and preparing for the next section.

I clean up each mold section and carve registration keys into its surface before I pour the adjacent section. I first scrape all the edges of the mold with a fettling knife to remove the thin sharp pieces of plaster. To clean the face of the mold I use water with drywall sandpaper and wet/dry sandpaper. It is very easy to take out a Styrofoam positive, clean and sand the plaster, and put back the positive without compromising its fit. If I am making a two-part mold, I don't bother taking out the model. I sand around it and lightly on top of its edges with wet/dry sandpaper to get the plaster level to its surface. If you are using a clay positive leave it in the mold and use a needle tool to remove any clay that adheres to the plaster close to your positive and to remove any plaster that may be on the clay positive. If you are using a bisque piece it needs to be removed and soaked in water between pouring adjacent mold sections. To cut keys into the plaster use a quarter or a dime to create a half sphere indentation at two or three locations on the surface.

Prior to pouring the next section coat all the surfaces of the plaster, even the bottom, and all the surfaces of the model liberally with the Murphy's Oil Soap solution. Place the mold on the Plexiglas, arrange the cottles and clamp the cottle boards together. Seal any seams between the boards and plaster with coils of clay, Murphy the cottles. Estimate the volume of water needed for this section, then mix another batch of plaster and pour it over the first section to the desired height. Put your fingers into the plaster and slide them over the first plaster section, the model and the sides of the cottles to release any air bubbles on their surfaces.

After all of the sections are poured you should be able to get the mold apart after 2–3 hours with a little help from a fettling knife by using it to pry apart the sections. If it won't come apart easily, let it set over night. Remove the model sand the outside of the mold sections to eliminate any rough edges that could break off, sand the inside where needed check that the interior seems line up while the mold is together and re-sand if necessary wash the mold off with water and place the separated mold sections into a dry box. If you do not have a dry box place the assembled mold in front of a fan. Placing it on a rotating wheel head in front of the fan is preferred so it dries uniformly.

Slip-Casting

When the mold is completely dry and before I use it for the first time, I submerse each piece into a tub of water for a few seconds, this starts the capillary action within the plaster so that the casting process works more quickly. Next, remove any remaining Murphy's Oil Soap that is on the casting area with vinegar. You can tell where the Murphy's is because the plaster will remain wet in those areas. Your first cast will probably not release easily from the mold so gently use compressed air at 35 to 50 psi aimed at the casting-slip/mold interface in the pour spout of the top section, around the edges where the mold sections meet, and slip meet on subsequent sections as parts of the mold are removed. If you don't have access to compressed air, just wait another 10-20 minutes before trying to remove it. Slips with ball clay tend not to release and compressed air is usually necessary for those slip bodies. If after two casts you are still having release problems check for any undercuts (areas where a plaster overhang prevents the clay from releasing) you may have missed. To check for undercuts, view the mold section from above, place a fingernail against the mold at the top edge and move it down toward the bottom of the section. Do this at various points around the mold's edge. If at any point you can't see the tip of your fingernail you likely have an undercut that will need to be sanded away.

I mix my casting slip in a 20-gallon bucket and sieve it through a 40-mesh sieve into a 5-gallon bucket. The spigot on the 20-gallon bucket is covered with a finger cut from a latex glove so the spigot does not get clogged with dry slip. The slip is then transferred into a 1-gallon pitcher that I use to pour shrink slabs (slabs that go under each piece that shrink with the work during drying and firing and thus prevent my pieces from warping) and to pour slip into the molds. The slip stays in the mold from 2-8 minutes depending on the size of the piece. I then tip the mold over and the excess slip is caught in a plastic tub. This slip is then sieved back into the 5-gallon bucket.

As soon as the piece stops dripping and the last drip on the cast surface is dry, the mold is placed up right, compressed air is used to release the form and the top plaster piece is removed. I then use compressed air to release the piece from the bottom plaster piece but leave it on the plaster while cleaning the foot and bottom sides. Leaving the work on the plaster while I clean it allows it to firm up a bit more and gives the middle section support so it does not get deformed when I sign it. I use an Exacto knife to cut off the excess slip from the pour spout and trim the opening of the foot. These trimmings go into a reclaim bucket. A loop tool is used to remove the casting drips, I smooth the surface with a sponge and my finger and I sign my work with a dull pencil. I then use a sponge and my fingers to clean up the foot and sides of the piece. It is important to support the underside while putting pressure on the top of the casting while sponging it.

To get the work off of the plaster mold without warping it, a ware board or throwing bat is placed over the work and while keeping a few inches of the bottom part of the mold on the table the mold with the work is flipped 180º. I then rotate the mold back up, leaving the slip-cast piece on the ware board. I then clean the top part of the work. Flip the piece over using two ware boards and recheck the bottom to see if it needs any more cleaning, place the shrink slab on the bottom and using two ware boards, flip it back over. The work dries uncovered. When dry I place a kiln shelf onto my work table and level the ware board to the same height as the kiln shelf. The shrink slab (with the piece on top of it) is pushed and both slide as one onto the kiln shelf.