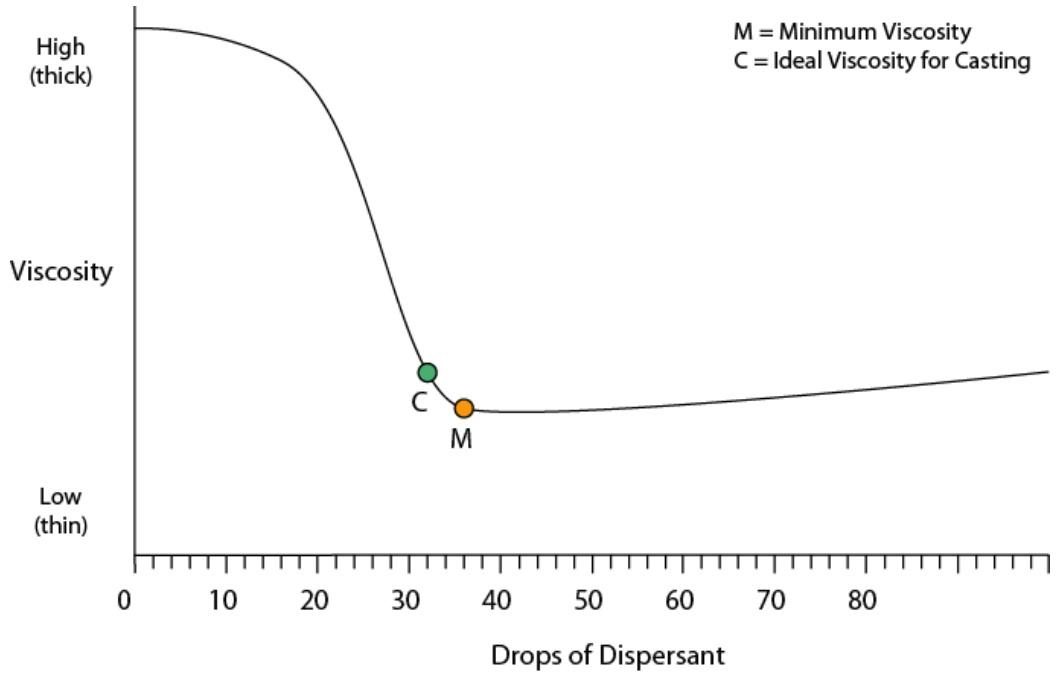
Determining Dispersant Additions for Casting Slips

Dispersant = A material that lowers the viscosity of the slip (i.e. Darvan 7, 811 etc.)
Viscosity (A.K.A. Fluidity) = High viscosity is thick; Low viscosity is thin

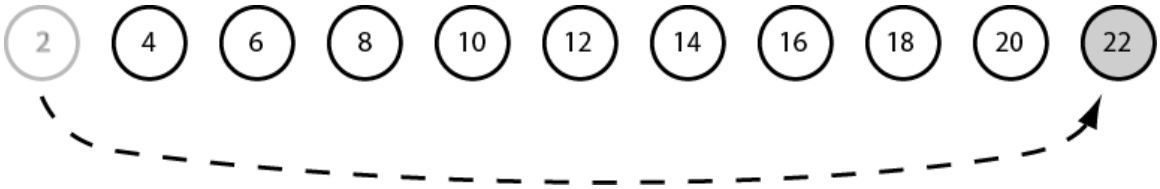
While you can incrementally add a dispersant to a single test and observe its effects on viscosity, changes in viscosity occur gradually, making it difficult to decide exactly how much dispersant is required to reach a minimum of viscosity. The following test gives you a clearer picture of when this minimum occurs.

1) Arrange 10 containers in a row; label the first "2" (2 drops), the second "4" etc. up to "20".
2) Add 80 grams (40%) of water to each container (water amount can vary depending on materials in the slip; 40% may be too liquid, or not liquid enough... you won't know until you actually do the test).
3) Add 2 drops of dispersant to the first container, 4 drops to the second etc. Using a small jiffy mixer, mix the dispersant in water so it is dispersed well.
4) Sift 200 grams of your dry mixed clay body to each container; mix each container *thoroughly* with a small jiffy mixer.
5) If the most fluid sample is the last one (i.e. container with 20 drops), then add 20 drops to the first container (which now has 22 drops), re-label it "22" and place it next to the container with 20 drops (the first sample in the test now becomes the last).
6) Repeat step 5 until you don't notice the samples getting any thinner. The sample where viscosity no longer drops is your minimum point. Keep adding dispersant to samples so that this minimum point falls in the middle of the set of samples.
7) As you get close to your minimum, stir each container by hand with a wide, flat stir-stick. This will help you decide which sample is thinnest. To compare two samples, pull stir sticks out of the containers and see how the slip drips off them. The minimum point will drip longer and more consistently.

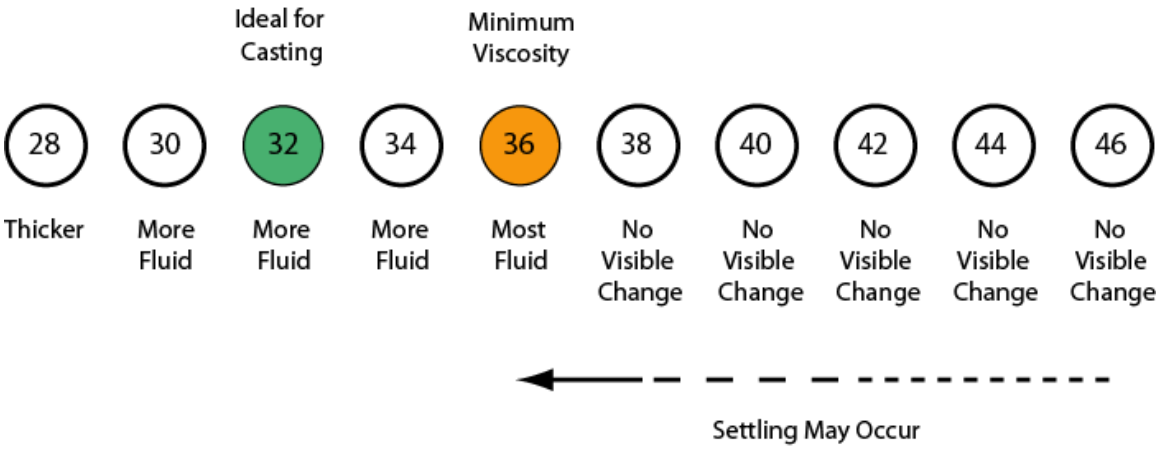


Starting arrangement of containers…

Adding 20 drops of dispersant to a thick sample, then re-arranging its position in the line. This is repeated until the minimum viscosity is found…



Zeroing in on the ideal point…



For creating a casting slip don't use the minimum viscosity point, as non-plastic materials (i.e. Flint, Feldspar etc.) can settle out over time. Instead, use the sample 2-4 drops back from the minimum. This will help keep your non-plastics suspended.

Calculating the Amount of Dispersant Used

The dropper you use, along with the angle at which you hold the dropper, will determine how much dispersant is contained in each drop. Our scales are not accurate enough to measure a single drop of dispersant. Instead, weigh out 50 drops of dispersant and divide the total weight by 50 to figure out the weight of one drop. Multiply the weight of one drop by the total number of drops for your chosen point. Divide this number by 2 (since your batch weight is out of 200 grams). The result gives you the percentage of dispersant used.

Example:

50 drops weigh 1.8115 grams; 1.8115 / 50 = 0.03623 grams per drop
If I decided my ideal sample used 36 drops of dispersant, then…

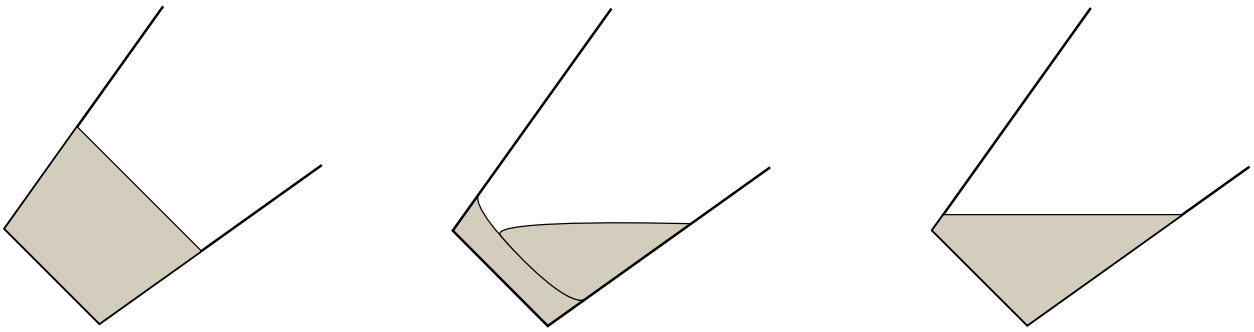
36 * 0.03623 = 1.30428 grams of dispersant used for a 200 gram sample of dry material
1.30428 / 2 = 0.6521 grams of dispersant used for a 100 gram sample of dry material

Or 0.6521% dispersant used.

Testing for Short-Term Gelling and Settling

1) Briefly mix all 10 points to destroy any previous gelling.
2) Let samples sit undisturbed for the period of time you expect the slip to be in your mold (i.e. 10-30 minutes, depending on the desired wall thickness of your cast).
3) Tilt each container at 45 degrees. Note how the top layer of material moves.
   Fully-gelled samples - won't move at all.
   Somewhat-gelled samples - the top layer of slip will separate from below and will move as one (like an avalanche).
   Non-gelled samples – material will move freely, with no noticeable difference between top and bottom.

Fully Gelled *Somewhat Gelled* *Non Gelled*



For slip casting, we are looking for samples that won't gel during our anticipated casting period. A slip that gels too early will be difficult to drain from the mold. If all samples gel after this short period, add 2% water to each sample and test again. Beyond 45% water, you may need to consider removing some of the fine materials from you recipe.

4) Having tested for short term gelling characteristics, swish the first container back and forth a few times to destroy any gelling. Tilt the container and allow the slip to sheet off, revealing the base. Scrape the bottom of the container with a flat non-porous utensil (plastic or metal knife works well) in a straight single line. Inspect both utensil and container for any signs of sediment. This will be evident as a denser layer than the slip. Make a note of whether you find sediment in the sample.

5) Repeat step 4 for all 10 containers.

If settling has occurred, it is the non-plastic part of the recipe. Settling is more likely to happen as your samples get closer to the minimum viscosity point. Also, bodies with large amounts of non plastics (especially grogs) are more likely to show signs of settling early on.

If settling occurs in all samples, try using less water next time, or encourage more gelling by increasing fine clay in the recipe.

Testing for Long-Term Gelling and Settling

Having tested the gelling conditions above, let the samples sit overnight and re-test to see if the slip gels or settles. A slip that does gel over this longer period of time can be beneficial, as this will prevent settling from occurring.

Example of a Test using the above procedures

Reciepe: CS#8

16.25 Grolleg
16.25 Tennessee #10
10.83 Hawthorn Bond 35
16.25 Wollastonite
10.83 Pyrax
27.08 Fine Grog
2.51 3124
100%

Test with 35% water; Darvan additions done with a plastic syringe
1 drop of Darvan 7 = 0.05264 g

Viscosity Test (200 gram samples)

0 drops (no Darvan) –Thick Paste
2 drops (0.0526%) -Paste
4 drops (0.1053%) -Paste
6 drops (0.1579%) -Paste
8 drops (0.2106%) -Paste
10 drops (0.2632%) -A little wetter but still paste
12 drops (0.3158%) -Noticeably wetter but still not fluid
14 drops (0.3685%) -Same
16 drops (0.4211%) –Fluid when mixing/almost pourable
18 drops (0.4738%) –Much more fluid when not mixing/very thick syrup
20 drops (0.5264%) -Same
22 drops (0.5790%) –Bubbles rise on their own when not agitated/thinner than 18 drops/less resistance when stirring

24 drops (0.6317%) -Same
26 drops (0.6843%) –Consistency of thick cream
28 drops (0.7370%) -Same
30 drops (0.7896%) -Same
32 drops (0.8422%) –Very little resistance to stirring
34 drops (0.8949%) –No noticeable change
36 drops (0.9475%) - No noticeable change
38 drops (1.0002%) - No noticeable change

Gelling Test After 45 Minutes

18 drops (0.4738%) –Gels heavily
20 drops (0.5264%) -Same
22 drops (0.5790%) –Gels but starts to move when container is tilted
24 drops (0.6317%) –Same
26 drops (0.6843%) –Same
28 drops (0.7370%) – Very little gelling
30 drops (0.7896%) - Same
32 drops (0.8422%) – No gelling
34 drops (0.8949%) – No gelling
36 drops (0.9475 %) - No gelling
38 drops (1.0002%) - No gelling

Settling Test After 1 Hour

18 drops (0.4738%) –No settling but coagulates at the bottom/doesn't sheet nicely when tipped
20 drops (0.5264%) -Same
22 drops (0.5790%) –No settling/Starts to sheet nicely
24 drops (0.6317%) –No settling
26 drops (0.6843%) –No settling
28 drops (0.7370%) - No settling
30 drops (0.7896%) - No settling
32 drops (0.8422%) – No settling
34 drops (0.8949%) – No settling
36 drops (0.9475 %) - No settling
38 drops (1.0002%) - No settling

Settling and Gelling Test After 12 Hours

None of the samples from 22 to 38 drops showed any noticeable settling. All gelled overnight.

Conclusion

Use 32 drops (.8422% Darvan) because this point seems to be the most liquid, and it doesn't gel right away.