TECHNO FILE

suspenders and

Potent additives can make your life much easier and increase your glazing success. The drudgery of extensive stirring and the flaws from fragile unfired glaze coatings can be put behind you.

Defining the Terms

Gum—In the context of glaze chemistry, organic compounds derived from plants, bacteria, or fungi, that act as suspenders and/or binders. In many ceramics studios, the word is also often applied to the mineral suspenders.

Suspender—Any additive whose primary purpose is to slow or eliminate settling, and sometimes to prevent the glaze from settling as hard. Most suspenders are also binders.

Binder—Any additive whose primary purpose is to harden the dry, unfired glaze coat.

Organic—Chemicals mostly made of carbon. Unlike most glaze chemicals (which are inorganic minerals), organic compounds can be food for bacteria and therefore must either be used up quickly once mixed or mixed with an antibacterial preservative.

Brushability—Desirable properties for brushing glazes are a) slower drying time to make for smooth brush marks; b) reduced surface tension to allow glaze to flow into fine detail (a few drops of common dish soap will reduce the surface tension of any glaze. The small mineral content of this soap is unlikely to affect the fired appearance); and c) harder drying to prevent lifting and flaking from additional brush passes.

Viscosity—The resistance of a fluid to deformation such as from stirring or pouring. Water is an example of a low viscosity liquid and honey of a high viscosity liquid.

Fluidity—The opposite (reciprocal) of viscosity. Water has higher fluidity than honey.

Thixotropy—The property of some clays and glazes that are solid or semi-solid (gelled) under static conditions to become dramatically more fluid when stirred or otherwise agitated. Thixotropy is closely related to the terms *shear thinning* and *pseudoplasticity*, but only the term thixotropy is commonly used in ceramics studios, even when actually referring to shear thinning.

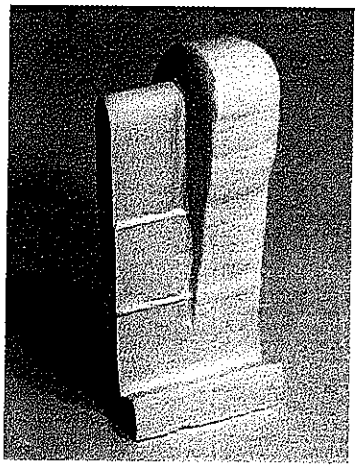
Shear Thinning—Very similar to thixotropy, but whereas thixotropic materials become increasingly more fluid with continued but constant shear rate, shear thinning fluids only become more fluid with increasing shear rate. For any thixotropic or shear thinning material there is a yield value, a minimum shear stress that must be applied for viscosity to decrease (think of how hard you have to whack the bottle of thixotropic ketchup).

Pseudoplasticity— A more general fluid mechanics term that encompasses both thixotropy and shear thinning.

Gaining Control of the Mix

A suspender is simply any additive whose primary purpose is to slow or eliminate settling. They typically work by absorbing a huge amount of water, thereby thickening (increasing the viscosity of) the glaze. A binder is any additive whose primary purpose is to harden the dry, unfired glaze coat. Binders usually make it easier to apply multiple and thick glaze coats. Most of these materials function as both suspenders and binders; there is only one common material that is exclusively a binder, and that's gum arabic. Only flocculents can sometimes improve suspension while actually worsening binding. Therefore, for the rest of this discussion, the word suspender will mean suspender/binder.

Because suspenders absorb so much water, glazes containing them shrink more when drying. This can sometimes lead to cracking and crawling, especially when suspenders are used in quantities exceeding the recommended ranges, but more often suspenders actually decrease cracking because their binding power increases cohesiveness and because they dry slowly, which gives the glaze more time to adjust to the stress of shrinking.



Repeatedly dipped in a simple glaze (100% frit with 3% added MAGMA), the above tile shows how a good binder allows unlimited glaze layering as well as carving. The glaze on the left half of the tile was carved away without chipping the remaining glaze.

These additives can be broadly divided into organic and mineral categories. Mineral suspenders are clay-like minerals and are, by far, the most frequently used (when added to clay bodies they increase plasticity, but mixed up by themselves they are not plastic and so are not clay). They can be used as the only suspending material in a glaze. Their effects on suspension are more dramatic than on binding, but they do improve binding. They become part of the fired glaze, but because their chemical composition is similar to clay (and they are typically used at only about 2% of dry ingredients) they usually do not noticeably alter the final appearance. The most common mineral suspenders are bentonite and Veegum-T. There are many different sources of bentonite, varying somewhat in strength and quite a bit in iron and other impurity content. In most circumstances the different mineral suspenders can be used interchangeably, perhaps with a small adjustment in quantity to account for different potencies. Mineral suspenders usually exhibit thixotropy, which means that they gel when not being stirred. This improves suspension more than simply increasing the viscosity, sometimes completely preventing any settling.

Organic suspenders, usually called gums, are usually even more potent in most ways than the mineral suspenders. They also have the advantage of almost completely burning out and therefore leaving the fired glaze unaltered. Many of them also are more effective binders than the mineral suspenders. One drawback is that they will rot after several days to months if there is no preservative. Not only do they lose effectiveness, but it makes a nasty stink. This rotting is easily prevented by the addition of a preservative. There are some preservatives sold specifically for this, but they are quite toxic to people as well as to the bacteria. I have found the best preservative is one you already have in your studio: copper carbonate. It only requires 0.04% of total dry batch (0.4g $CuCO_3$ per 1000g dry glaze) to indefinitely prevent rotting. This amount of copper, if properly dispersed, is almost never visible in the fired glaze.*

binders for glaze

by David Pier

Suspenders, most dramatically the organic gums, also slow the drying of glazes. Sometimes this is an advantage, as it allows easier brushing, or touching up of drips after dipping. Too slow, though, and glazing takes longer, since it is hard to put the piece down until the glaze has dried. If you start your experimentation with usage levels at the lower end suggested in the chart, and then work your way up, you will find the quantity that balances suspending, binding, and drying time to best suit your work habits. CMC gum is particularly potent in slowing drying.

CMC gum is the most common gum and is typically used in brushing glazes, as it is better at binding and slowing drying than it is at suspending. CMC doesn't exhibit thixotropy, and can actually reduce any thixotropy already present, so it only slows rather than prevents settling. Much of CMC's prevalence is due to CMC having been available for many decades before most of the other gums. A recently introduced organic gum, MAGMA, exhibits strong thixotropy and can prevent settling of any glaze, indefinitely, without as much slowing of drying time as CMC. Because of the thixotropy, MAGMA is more or less suitable for different brushing techniques. (MAGMA is suitable for all applications, but CMC is often preferable for brushing since it provides smoother brushstrokes due to slower drying. However, that should be weighed against the potential for dripping of CMC glazes on dipped pots.)**

There are many other organic gums available, although not usually from ceramic suppliers. Most of them behave similarly to CMC gum, although potency varies widely.

Tips for Smooth Mixing

If you leave these additives out of your slips and glazes, they'll look pretty much the same after the firing as if you had put them in. So why bother? Imagine big buckets of glazes that only need a few seconds of stirring, even if they have been sitting unused for over a year. Imagine unfired glazes that never chip because they are as hard as the bisque they are applied to! It isn't magic that makes commercial, ready-to-use glazes so easy to use; it's the additives. Most of these materials are sold as dry powders. If you sprinkle them into your already-mixed glazes, you'll get little globs that will hinder rather than help glazing. If you try to sieve them, you'll be trying all day and night. Below are two basic methods of adding suspenders to your slip or glaze while avoiding clumping and excess water.

Add to an Existing Wet Glaze

a) Calculate/estimate the maximum amount of suspender you might end up using in the batch. If you end up mixing more than you need, consider mixing in a preservative.
b) Add suspender powder to hot water; for every 20 grams suspender add to about 80 ml of hot water, then add a little more water bringing the concentrate to a total of 100 ml.
c) Mix with a hand blender, or wait a few hours for the mixture to thoroughly combine into a gel/syrup; depending on the suspender it might take some time, even overnight.
d) Add gel/syrup in small increments to your glaze.
e) Mix together with an electric mixer until the suspender is thoroughly dispersed.

CMC Gel/Syrup to Wet Glaze

Mixed Wet Glaze (approximate amounts)	CMC Gum Gel/Syrup (approximate amounts)
4 oz.	add ¾ tsp.
20 oz.	add 3¾ tsp.
40 oz.	add 2½ Tbsp.
1 Gallon	add ½ cup
3 Gallons	add 1½ cups

Add Suspender to a Dry Glaze Batch

a) Calculate and weigh out an appropriate quantity of suspender, add preservative if necessary. (Typically .5–2%; for the example below we are using .75%)
b) Mix suspender (and preservative powders) with the glaze dry ingredients. The combination and mixing of dry ingredients will prevent the suspender from clumping.
c) Use hot water unless contraindicated by another ingredient. The hotter the water, the faster the dispersion will be.
d) Add the dry mixture to a normal amount of water for the glaze batch (the glaze will be thicker than normal). Wait a few hours to ensure full dispersion and absorption then sieve the glaze as usual.

Dry CMC Gum to Dry Glaze

Mixed Glaze Dry Ingred (approximate amounts)	Dry CMC Gum (approximate amounts)
100 grams	add .75 grams
500 grams	add 3.75 grams
1000 grams	add 7.5 grams
3500 grams	add 26 grams
10,000 grams	add 75 grams

Glaze Additives

MATERIAL	TYPICAL USAGE RATE***	REQUIRES PRESERVATIVE?	TOXICITY	IMPORTANT PROPERTIES
Bentonite, White Bentonite	.5%–3%	No	Inhalation Hazard	More properly sodium bentonite. Most common suspender. Mineral suspender and binder. Some bentonites contain enough iron to change the color of glazes. Calcium bentonite is sometimes used in clay bodies, but it does not aid in glaze suspension.
Veegum-T	.4%–2%	No	Inhalation Hazard	High purity and high potency bentonite produced by the R.T. Vanderbilt company. It has almost no iron impurity.
Veegum Cer	.2%–2%	Yes	Inhalation Hazard	Mixture of Veegum-T (for suspension) and CMC gum (for binding and brushability). More potent than either Veegum-T or CMC alone.
Bentone MA Bentone EW (aka Macaloid)	.4%–2%	No	Inhalation Hazard	Purified hectorite mineral suspenders produced by Elementis Specialties. Potent mineral suspenders with properties essentially the same as Veegum-T. Some grades have low iron similar to Veegum-T.
CMC gum	.05%–2% (powder)	Yes	None	A chemically modified cellulose gum (specifically, *sodium* carboxymethylcellulose gum—adding a tiny amount of soluble sodium to your recipe.) Most useful as a binder and brushing aid, aiding in smooth brushstrokes due to longer drying times. As a suspender, it slows settling instead of preventing it, since it does't exhibit thixotropy. The small sodium content can actually deflocculate any clay in the recipe, thereby reducing thixotropy, actually worsening settling over time. The same slow drying that can aid in brushing is often a nuisance in a dipping glaze, as the glaze can remain wet beyond a minute. Since CMC is manufactured in various grades, it doesn't always work as expected. Sometimes sold already mixed as a concentrated syrup, although there is no standard concentration.
MAGMA gum	.05%–3% (Typical glaze usage is .4%–1%)	Yes	None	Thixotropic organic gum blend. Can indefinitely suspend even a zero clay glaze when used at 3%. Strong binder
Starch, e.g. Sta-Flo liquid laundry starch	1%–100%	Yes	None	Poor suspender at low concentrations, mostly used for binding and improved brushability. Expensive compared to gums because so much starch is required to match the strength of gums.
Gum Arabic/ Acacia Gum	3%–30% (dry powder)	Yes	None	Binder/hardener only. Increases drying time. Does not significantly increase viscosity of glaze. In addition to binding, it reduces surface tension of liquid, allowing easier flow into fine detail. Also commonly sold already mixed as a liquid, mostly for use in watercolor painting, although there is no standard concentration.
Other food gums (guar, locust, bean, konjac, tragacanth, xanthan, etc.)	.1%–2%	Yes	None	Most food gums will behave very much like CMC gum, although usually without the deflocculation. Potency varies between different gums and even between different batches of the same gum. Most do not exhibit thixotropy. Some are available in the vitamin area of grocery stores.
Glycerin and propylene glycol	1%–100%	Yes	None	Very weak suspenders, used primarily to improve brushability. Does not increase drying shrinkage. Not very cost effective compared to gums.
Ethylene glycol (auto antifreeze)	1%–100%	Yes	Toxic through skin absorption or ingestion	Very weak suspender, used primarily to improve brushability. Very toxic and not very cost effective.
Flocculents (e.g. Epsom Salts, calcium chloride)		Some do	Varies	Chemicals that are sometimes used to aid in glaze suspension. They increase the water holding power of clays, bentonites, and similar materials, but not of organic gums. Flocculents typically make the dry glaze coat more fragile.

*Of course, copper is quite toxic to people, too, but it is not normally absorbed through the skin in large quantities. All normal precautions should be taken with this copper. This demonstrates how potent a toxin copper can be.

**MAGMA was developed by the author. He no longer has any financial interest in it.

***Lower for higher clay glazes, higher for lower clay glazes.