# Volume dosing

Alain Fichot

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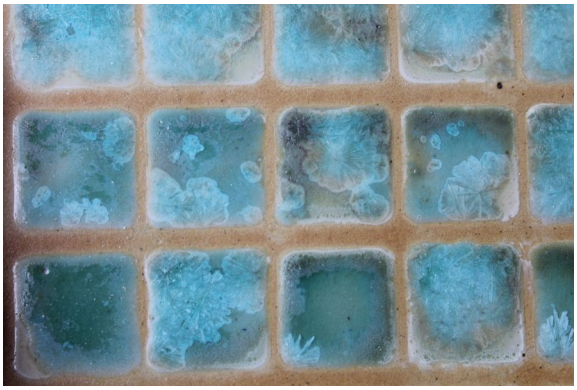
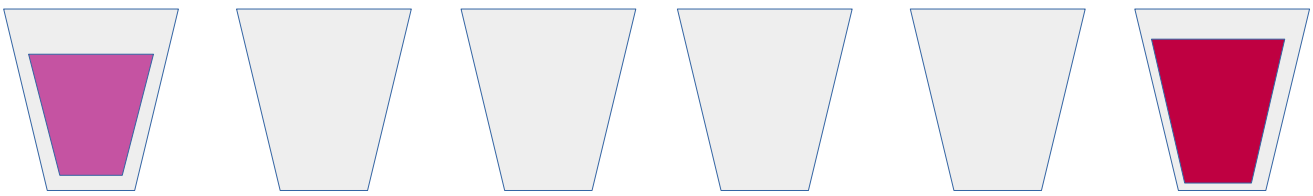


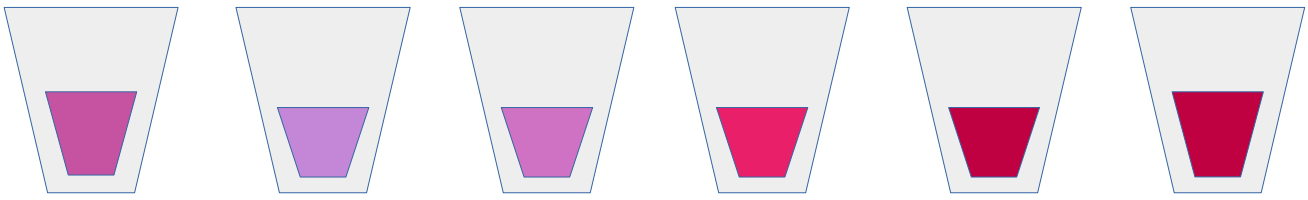
he volume dosing allows tests to be carried out much faster than weighing the samples one by one. A syringe can be used for this purpose. These are graduated. During the course we will use three volumes of syringes: 1ml, 3ml and 10ml. Ml means millilitre (1 gr for water) You could also use the drop but you need 25 drops of water to make 1ml and therefore to make glaze samples you would have to count too many drops. We will use the dropper only to measure the coloring oxides as we will see later.

## Application to an online progression

For example, we want to see the influence of a material in a basic recipe. For example, we will want to see what happens when more or less titanium is added to a recipe. We prepare 10 gr of this basic recipe and we will add 10 gr of water. We obtain 20gr of wet enamel. We divide it into two equal parts (or by weighing or volume) which we put in two wells A and B; we will therefore have 10 g of enamel in each well, or 5 g of dry matter per well. In well B we will add titanium, for example 8% (these 8% are calculated on the dry matter) or 0.4gr of titanium. We're stirring. Now if we want to do 6 samples for our progress we will have 6 buckets



and we go with a syringe to distribute in the 4 empty wells of enamel A and B to get this:



**A** **4A1B** **3A2B** **2A3B** **1A4B** **B**

Our notation indicates that in the first empty glass we will put 4 doses of A and one dose of B
in the second empty glass we will put 3 doses of A and 2 doses of B
in the third empty glass we will put 2 doses of A and 3 doses of B etc
The dose here may be 0.5 ml here. We will use the 3 ml syringes and put in the first empty glass 4x0.5ml or 2ml of A, then 1.5ml in the next glass, then 1ml etc. We will do the same for B in the other direction. After stirring, we brush on the tests that we will note with an oxide pencil A ,4A1B, 3A2B, etc. After cooking if we want to know the recipe of the wonderful sample that happens to be 3A2B we multiply the recipe of A by 3 and the recipe of B by 2 and we add the two recipes. In this case, as it is a limited addition to titanium of 8%, we will have an addition of 2-fifths of 8%, or 3.2%. (The tests correspond to 0%; 1.6%; 3.2%; 4.8%; 6.4%; 8%)

Note that some readers will say "but it is necessary to do this calculation!" and that is true. With this method I neglect the change in volume due to the addition of dry matter to the glass B But if this addition is small, the error produced is minimal and in any case lower than the errors inerrant to the relative accuracy of the use of the syringe. Therefore, the addition of material for recipe B will be done with a maximum of about twenty percent to limit this error. The relative accuracy of this method is largely compensated by its speed of execution. If you are interested in this accuracy, be aware that a volume measured with a 3 ml syringe will be estimated at less than one-tenth of a ml. I leave it to you to finish the error calculation and compare it to the use of a scale. I therefore proceed differently than the Ian Currie method, which adapts the addition of water in wells A and B to have the same volume of A and B, which gives a fair calculation in theory but in practice the adjustment to have the same volume is imprecise and is therefore a source of error. Is the imprecision less false than my theoretical error to you to see.....

# Using my test mold

I made an elastomer "ice cube tray" that will allow us to make a progression along two axes and transfer our samples directly to the tile without the use of the brush. (I call this tool an ice cube tray but if we use a commercial ice cube tray directly we may have some inconveniences especially when turning on the tile I have looked a lot for a supplier who would market this kind of tool for ice cubes or confectionery even if it meant redoing a support for the turning, but I have not found any whose dimensions satisfy me and the tests done have ended in failures)
This "ice cube tray" is composed of 5 rows of 5 cavities, each of which is about 5 cm². This dimension was chosen because, for me, it is a good compromise between the visibility of the test (good for most classic glazes) and the size of the tile of the 25 tests which will only be 13.5 x 15

cm. The cavities are "named" with the same numbering system as for the in-line progression but a little more complicated... You may think that the method requires a lot of work before you start making the first test and that it is not worth it but once this work is done beforehand this method becomes very fast

| | | | | |
|---|---|---|---|---|
| 4D | 1A3D | 2A2D | 3A1D | 4A |
| 1C3D | 1B3D | 1A1B2D | 2A1B1D | 3A1D |
| 2C2D | 1B1C2D | 2B2D | 1A2B1D | 2A2B |
| 3C1D | 1B2C1D | 2B1C1D | 3B1D | 1A3B |
| 4C | 1B3C | 2B2C | 3B1C | 4B |

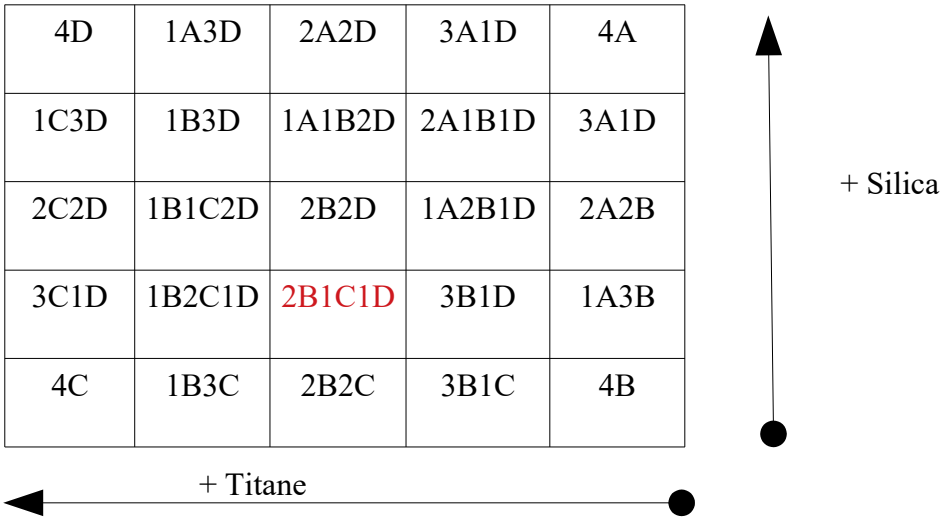
It may seem strange that on the top line the D is on the left and the A on the right but this is necessary to have after turning our mold on the tile, a finished tile with the A on the left and the D on the right.

## Example of possible progressions

For example, we could put a celadon in box A, an iron red in B, a Magesian white in C and a geranium ash enamel in D, but the results, perhaps very interesting, would be difficult to interpret. We will make more orthodox and especially more useful progress, such as

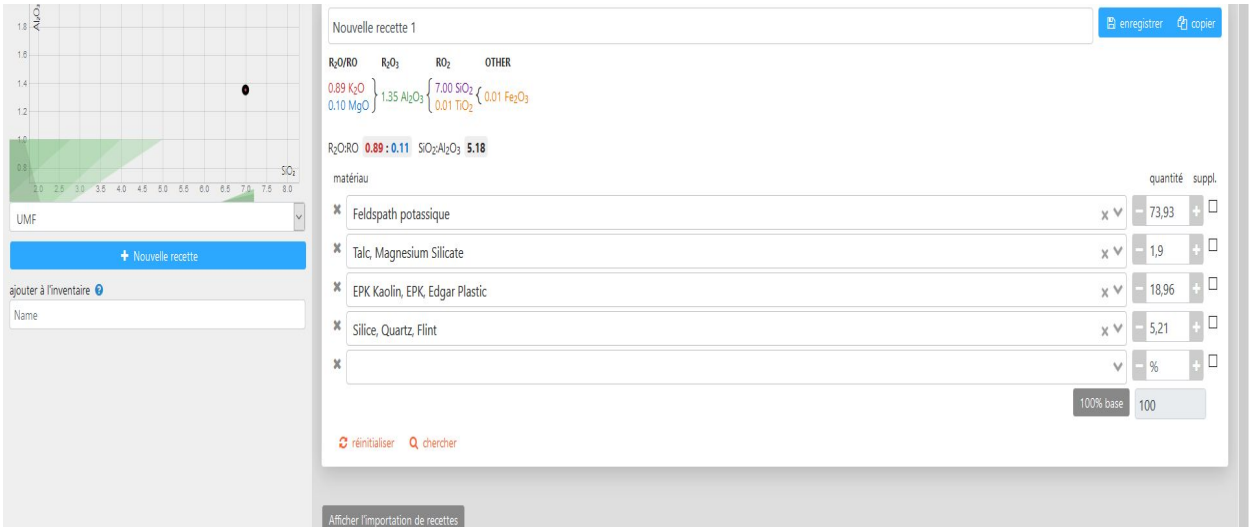
---- We take a base B which we divide into 4 equal parts. In well A silica is added for example 10%, in C 5% titanium is added, in D 10% Si and 5 Ti and for B nothing is added We will do as for the online progression by putting for example in box 2B1C1D 2 doses of B, one of C and one of D etc

| | | | | |
|---|---|---|---|---|
| 4D | 1A3D | 2A2D | 3A1D | 4A |
| 1C3D | 1B3D | 1A1B2D | 2A1B1D | 3A1D |
| 2C2D | 1B1C2D | 2B2D | 1A2B1D | 2A2B |
| 3C1D | 1B2C1D | 2B1C1D | 3B1D | 1A3B |
| 4C | 1B3C | 2B2C | 3B1C | 4B |

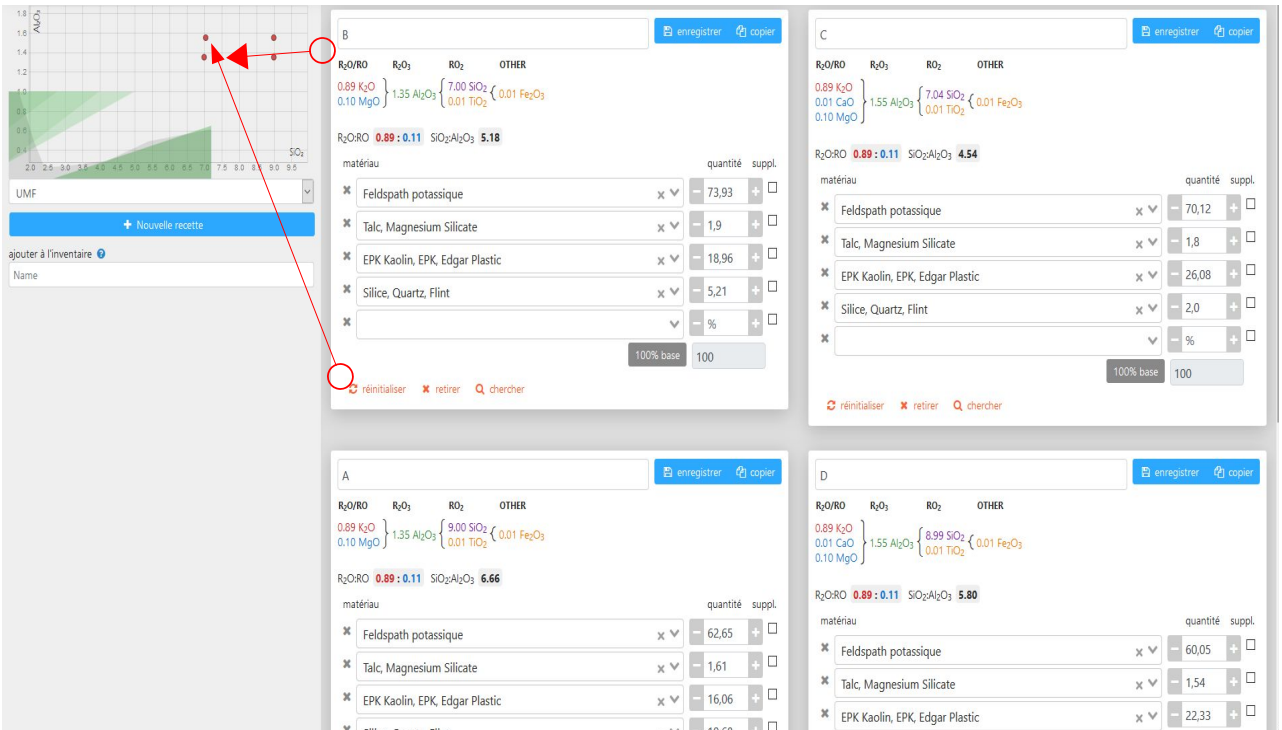


---- We may also want to see what happens in a given enamel when a frit, for example, is replaced by an alkaline frit, for example, with an additional variation on the silica. Recipe B is made with boracic frit, recipe C with alkaline frit. B is divided into two wells A and B; in the A 15% Si is added. The same procedure is followed for C and D. There are 4 wells A, B, C and D and proceed as before

---- You may also want to explore a small area of a given diagram. For example, in the diagram in the FDM booklet, diagram "59" (0.1 MgO 0.9 KNaO) can be used to vary alumina between 1.35 and 1.55 and silica between 7 and 9. For the calculations we will use Glazy We determine our point B with the Glazy calculator which is the place at 1.35 of Al2O3 and 7 of SiO2.




On the first copy we adjust the silica to 9, on the second copy we adjust the alumina to 1.55, on the third copy we adjust to have both 1.55 alumina and 9 silica. We click on the% button so that our 4 recipes are on 100 (this way it will be easier to make 10gr of each). Lower the screenshot of his 4 recipes Remarks: the alumina silica axes are reversed at FDM compared to Glazy (diagram at the top left)



Dilution
Water with this method plays an important role because how to dilute our glaze so that a certain volume in our syringe gives us the desired thickness of enamel on our sample. To do this, simply adjust the amount of water that will be added to the dry matter (MS) and the volume that will be placed in each box of our "ice cube tray".
We will want to put a certain thickness of enamel to make our samples, which is equivalent to saying that we want a certain weight per cm² of glaze. The problem is that some glaze families ask to be applied thicker than others, so with a weight per cm² greater than others. It is necessary to try because the mentions that we see lying around in books like enamel should have a consistency of fresh cream or crepe dough are vague and unusable. I prefer to talk about grams per cm2 and for example a common glaze can be tried at 0.08gr per cm² at first. This will give a thickness (when glazed with tempering) of about 0.4mm For those who are bored with the calculation, skip the following paragraph

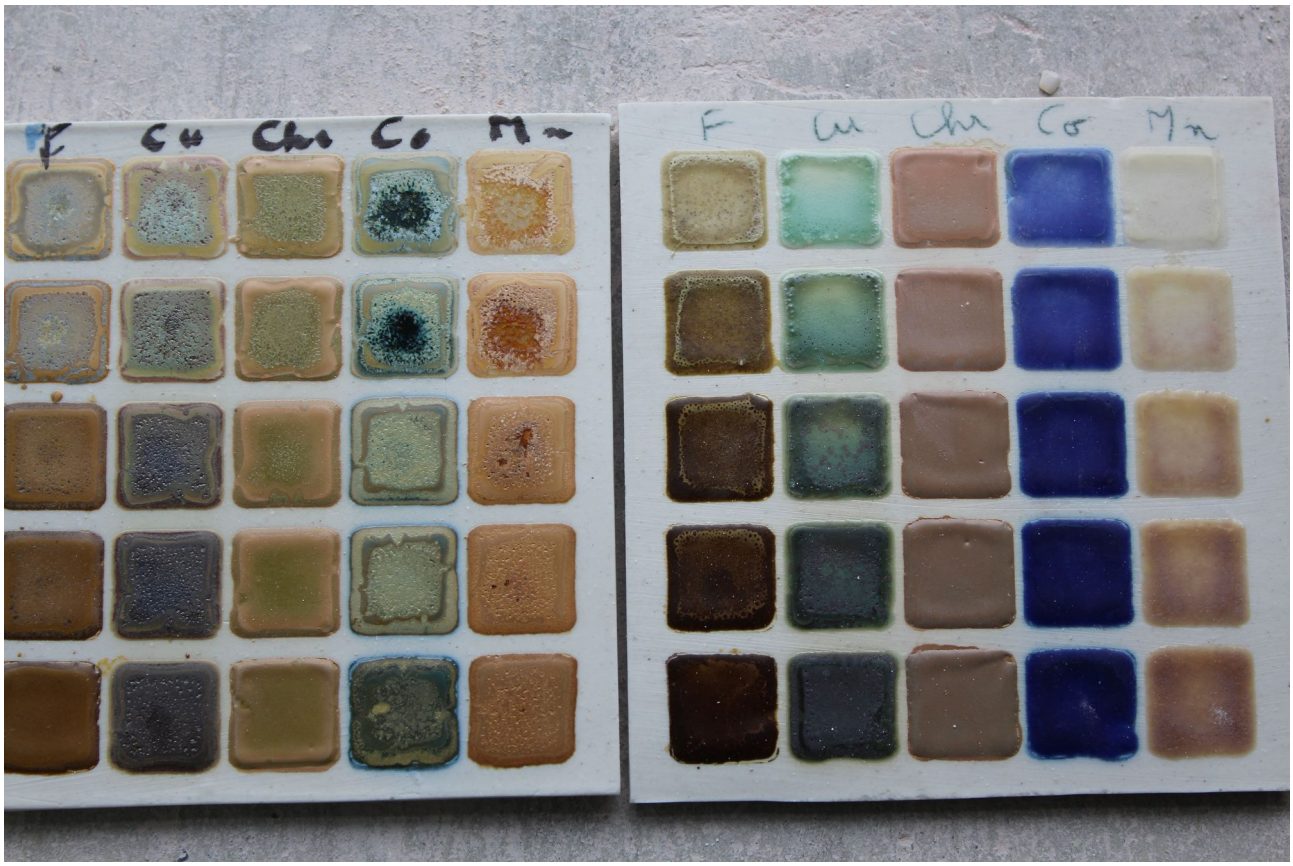
Knowing that the materials used in an glaze have a density of about 2.5 or 2.5gr per ml If we put a weight P of our dry matter in a volume Veal ( volume of water) we will obtain a Vémail (volume of enamel) which will be Veau+(P/2.5). Knowing also that to measure our enamel volume it is easier to use the 0.2 in 0.2 graduations for the 1 ml syringe we will try to have boxes containing 0.8ml of diluted glaze. So 0.4gr corresponding to 0.8ml, 10gr of MS corresponds to 20 ml and 10gr of MS making 4 ml to our 10gr of MS we will add 20-4 ml of water or 16 gr
We will add for 10 gr of MS 16 gr of water to have our chosen glaze thickness
When we have diluted our enamel correctly, just take out the syringe and fill our boxes as indicated on each box..... once the box is filled, we turn it over on the tile and note on the back of the tile the 4 recipes A, B, C and D. All that remains to be cooked.

In practice to improve the distribution of our glaze on the tile, an additional dilution of the glaze facilitates its reversal. It will be possible to put between 0.5 ml and 1 ml per box (at this level the precision does not matter because it is not the additional water that changes the quantity of dry matter deposited). Nor should this addition be exaggerated because the enamel must not take too long to dry on the tile. In addition, placing your elastomer crate on a foam itself placed on a wooden plate or another sample tile prevents possible leaks when turning over because it absorbs any defects such as warping of your tile.

In the example above we wanted 0.4 gr of MS per box with a volume of 0.8 ml of enamel per box (i.e. doses of 0.2 ml) but we may want to make a more or less thick glaze. So here is a table that links the weight of dry matter to the dilution. For example, if we want a thinner glaze at 0.3 gr per box, we will dilute our 10gr of MS with 23gr of water and make doses of 0.2 ml or 0.8ml per box. If we want 0.8 gr per box we will dilute it to 11 gr of water for 10 of MS and we will take a dose of 0.3 ml (and not 0.2) to have 1.2 ml per box. For even greater thicknesses we will make doses at 0.5 ml etc. At first, except for special glazes, we can use only the 0.4 line

| MS in gr | V in ml | Water for 10gr | V in ml | Water For 10 gr | V in ml | Water For 10 gr |
|---|---|---|---|---|---|---|
| 0,3 | 0,8 | 23 | | | | |
| 0,4 | 0,8 | 16 | | | | |
| 0,5 | 0,8 | 12 | | | | |
| 0,6 | 0,8 | 9 | 1,2 | 16 | | |
| 0,7 | | | 1,2 | 13 | | |
| 0,8 | | | 1,2 | 11 | 2 | 21 |
| 0,9 | | | 1,2 | 9 | 2 | 18 |
| 1 | | | | | 2 | 16 |
| 1,2 | | | | | 2 | 13 |
| 1,4 | | | | | 2 | 10 |

Another use of our "ice cube tray": colour tests with the use of drop counters
We want to do color tests with oxide or dye in a given glaze.
I made a video of this method https://youtu.be/NUAIc5UCCm4




We have 5 vials with caps with dropper in which we put 10gr of water. Iron is added in the 1, manganese in the 2, copper in the 3 etc. for iron, manganese copper we will put 0.8 gr of these oxides, for cobalt 0.08 gr . We will prepare a glaze that we will dilute as mentioned above (i.e. to have 0.4 gr per box) and we will fill our boxes with 0.8ml of enamel. Then we will put for the first column of our rack 1 drop of iron diluted in the first box, 2 drops in the second etc. same for the column2 with Mn etc. The dilution in our vials is such that each drop corresponds to 1% oxide except for cobalt where it could be 1 per 1000 . So when unloading it will be enough to choose the color that suits you best. We can also try mixtures of oxides for example, 3 of Cu, 2 of Co so 3% of copper and 2 per thousand of cobalt for a blue green.... In short the possibilities are endless but the method is really very fast compared to the individual weighing of the tests.

There are other uses for my tool, I will come back to this later.

By way of conclusion
My research method is similar to other methods such as those of Jean Meissen who "weighed" him in drops, it is a very fast method but it has the disadvantage of making samples a little small. Ian Currie's method is interesting and adapted to a systematic search, i.e. a search where you explore a whole diagram. Personally, I try to limit my search field. For example, I never look for glazes with less than 1.5 mol of silica for reasons of mechanical and chemical stability of the fired glaze. On the

other hand I limit my research to glazes will have a good melting, i. e. their theoretical melting temperature calculated for example with online-glaze-calculator is close to my firing temperature. For crystallizing enamels, I further limit the field of investigation.
The search for enamel is a bit like the search for mushrooms, for example if I want to search for mushrooms in my village, which is 50 km², I can plan to grid the entire territory of the commune every 10 metres. That's 5000 km to go... it's a long way to walk. So I add a criterion: the mushroom grows in the woods... right away we only have 2000 km to walk and as I don't want to go to the Douglas forests, I only have to drive 500 km. We can add other criteria for example not to go to places where everyone goes!....
In short, the search for enamel is vast and I wish you beautiful discoveries

Fait à Anost 26/11/2019