

# User Guide for EuCal version 1.91

## Introduction:

EuCal, or Eutectic Calculator, is used for understanding ceramic glazes. It is based on the idea that all glazes have a clear, transparent, glass at their base. A stony matte, for instance, can be made by starting with a transparent base and increasing the alumina. The glassy base is made up mostly of eutectic mixtures formed with the fluxes in the recipe, along with silica and alumina. A transparent glaze might be made up entirely of these eutectic mixtures, but most glazes have other ingredients that modify the glass by changing its color, making it opaque, or muting the gloss.

Like most glaze calculators, EuCal takes a recipe of ingredients and converts it into a unity molecular formula, or UMF. But it also separates the formula to show which parts contribute to the glassy base (the eutectics) and which are the “excess oxides” contributing to the character of the glaze.

## New for Versions 1.8, 1.9 & 1.91

Version 1.8 added borate eutectics for the alkali fluxes ( $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$  and  $\text{Li}_2\text{O}$ ). Version 1.9 added a calcium borate eutectic. Hopefully, these additions will extend its usefulness to lower temperature glazes. The chemistry of borates in ceramic glazes is very complex and much of it is not well understood. The borate eutectics now used in EuCal are a start, but do not account for all possible borate interactions. In Version 1.91 the %Analysis page was updated courtesy of Dick White. It is also unprotected, so users can see and modify all of the calculations.

## System Requirements

EuCal is designed for use with Microsoft Excel. Other spreadsheet programs, like “Open Office” may also run EuCal, but have not been tested. It does not work with “Google Sheets.”

The spreadsheet uses a macro which may not function if your security level is set too high, or if you are using a program other than Excel. The spreadsheet will work just fine without the macro, but it may not fit your screen correctly. You can fix that problem manually by adjusting the Zoom feature under the View menu tab.

## Using the Calculator:

EuCal is pre-loaded with an example glaze – Glaze N505 from ceramicartsdaily.org “15 tried & true cone 6 glaze recipes.” Try substituting ingredients or adjusting the % amounts to see how the formulas change.

The spreadsheet is divided into four Blocks. The purpose of each Block is described here.

**The Recipe Block:** (This is where you enter your recipe.)

When you click any cell in the “Mineral” column, you will see an arrow appear in a bottom corner of the cell. Click the arrow and you will see a menu of available ingredients. Use the up and down arrows in the menu to scroll through the list. Click your selection.

Enter the recipe amounts in the “%” column next to the Mineral ingredient. The “Fit 100%” column will automatically adjust the amounts to add up to 100.

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If you want to use an ingredient not on the list, you can add new ones in the “% Analysis” tab (sheet). Go to the bottom of the list and enter the oxide percentages in the appropriate columns. Once you do that, your new ingredient will automatically appear in the pull down menu. Be sure to save the spreadsheet with a new name so your change will be permanent.

The “Batch Multiplier” lets you multiply the amounts to fit your needs. For instance, for a 5 kg batch, set the multiplier to 5000. Instead of adding up to 100, the ingredients will now add up to 5000.

There are three copies the “Recipe to Formula” tab so you can have up to three recipes active at the same time. This is useful for comparing different recipes.

## **The Formula – Standard Molecular Unity Block:**

The cells under “Formula – Standard Molecular Unity” show your glaze recipe converted to a molecular formula. This is the classic method used in most glaze calculators. Some call it the Seger Formula or the Empirical Formula.

## **The Formula – Eutectics Only Block:**

This block shows the molecular formula for the glass part of your glaze – the eutectics.

## **The Oxides Excess to the Eutectics Block:**

Cells in this block show which oxides are not part of the “glass”. These are the modifiers that give the glaze its character. Most stoneware glazes can tolerate 0.5 units of excess SiO<sub>2</sub> and 0.05 units of excess Al<sub>2</sub>O<sub>3</sub> without much change. Many can tolerate even more SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub>, especially at higher temperatures. Excesses of other oxides may modify opacity, gloss, fluidity, color, etc. Some may simply remain dissolved in the glass.

## **The SrO and MgO switches:**

At the top right of the form are two switches called Include SrO Eutectic and Include MgO Eutectic. These two eutectics have high melting points that they may not be appropriate in all calculations. Turn them on or off as you wish. The melting point of the strontium eutectic is about cone 5. The melting point of the magnesium eutectic is about cone 13.

## **Limitations:**

The eutectics incorporated in EuCal version 1.91 are shown below. I selected the best I could find for each of the important fluxes. If their ingredients are present, and their melting points are exceeded, these eutectics are likely to form. Other eutectics are possible and interactions between them are likely. EuCal does not work well for specialty glazes that have little or no alumina – like some zinc crystal glazes and some Shinos because binary eutectics, like Na<sub>2</sub>O-SiO<sub>2</sub> and K<sub>2</sub>O-SiO<sub>2</sub>, without Al<sub>2</sub>O<sub>3</sub> are not (yet) included in EuCal. EuCal is an approximation.

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## Disclaimer:

EuCal is not a commercial product – it was developed for my own personal use. Realizing it has a unique way of looking at glaze chemistry, I decided to share it, hoping that others might find it useful and maybe help refine the idea. The contents of this calculator have not been independently validated. Let me know if you have problems or find errors.

## Eutectic Formulas used in EuCal version 1.91

#	K <sub>2</sub> O	Na <sub>2</sub> O	Li <sub>2</sub> O	CaO	MgO	BaO	SrO	ZnO	B <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	MP°C	MP°F
1	1.00								2.12		2.85	630	1166
2	1.00									0.10	3.42	695	1283
3		1.00								0.29	2.44	732	1350
4		1.00							1.30		1.73	790	1454
5			1.00						0.70		0.30	802	1476
6				1.00					1.51			990	1814
7			1.00							0.23	1.68	1026	1879
8				0.54				0.46		0.13	1.39	1030	1886
9						1.00				0.41	4.01	1122	2052
10				1.00						0.35	2.49	1165	2129
11							1.00			0.21	2.80	1176	2149
12					1.00					0.34	2.03	1350	2462

## Contact:

I welcome your questions, comments, and suggestions

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("Dulusion" is a silly name for a person from Duluth.)

Some of my work can be seen at [bobmagnusonpottery.etsy.com](http://bobmagnusonpottery.etsy.com)