Introduction:

Ceramic glazes are made up of two groups of ingredients: those that come together to form a clear, transparent glass, and those that modify texture, color or opacity. The first group is made of eutectic mixtures and always contains fluxes, silica, and alumina. The second group can include any oxide, including those in the first group that are not part of the eutectic mixtures.

EuCal is a spreadsheet for examining stoneware glazes. Like most other glaze calculators, it converts a recipe into a standard unit molecular formula or UMF. EuCal also separates the formula, showing which oxides form the glass and which are the modifiers.

System Requirements

EuCal is designed for use with Microsoft Excel and should work with any version, old or new. Other spreadsheet programs may also run EuCal, but have not been tested.

The spreadsheet uses macros which may not function if your security level is set too high. Most of the spreadsheet will work without the macros.

Using the calculator:

EuCal is pre-loaded with an example glaze – a version of the classic 4-3-2-1 clear glaze from Bernard Leach’s *A Potters Book*. Try substituting ingredients or adjusting the % amounts to see how the formulas change.

The spreadsheet is divided into several 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.

If you want to use an ingredient not on the list, you can add new ingredients at the bottom of the “%Analysis” tab. 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.

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.
The “Batch Multiplier” lets you to multiply the amounts to fit your needs. For instance, for a 5 kg batch, set the multiplier to 50. Instead of adding up to 100, the ingredients will now add up to 5000.

There are three copies the “Recipe to Formula” tab. 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$_2$ and 0.05 units of excess Al$_2$O$_3$ without much change. Many can tolerate even more SiO$_2$ and Al$_2$O$_3$, especially at higher temperatures. Excesses of other oxides may modify opacity, gloss, fluidity, color, etc.

**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 such high melting points that they may not be appropriate in all calculations. Turn them on or off as you wish. I rarely use strontium and usually turn the MgO switch off (no check mark.)

**Limitations:**

EuCal was designed for studying stoneware glazes. It may or may not be useful at lower temperatures.

The calculator does not take Borate eutectics into consideration. If Gerstley Borate or a borate frit is used in a recipe, the B$_2$O$_3$ shows up as an excess oxide.

The main guts of the calculator are hidden and password protected to prevent the spreadsheet from becoming accidentally corrupted. If you are interested in making modifications, contact me and I will send you a current, unprotected version. My email address is at the end of this document.

The eutectics incorporated in EuCal ver 1.3 are shown below. Many others are known to exist. I selected the best aluminosilicate eutectic I could find for each of the important fluxes.

The contents of this calculator have not been independently validated. Please let me know if you find errors.
Eutectic formulas used in EuCal

<table>
<thead>
<tr>
<th>#</th>
<th>K$_2$O</th>
<th>Na$_2$O</th>
<th>Li$_2$O</th>
<th>CaO</th>
<th>MgO</th>
<th>BaO</th>
<th>SrO</th>
<th>ZnO</th>
<th>Al$_2$O$_3$</th>
<th>SiO$_2$</th>
<th>MP°C</th>
<th>MP°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.174</td>
<td>4.468</td>
<td>800</td>
<td>1472</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0.278</td>
<td>7.022</td>
<td>870</td>
<td>1598</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0.2283</td>
<td>1.6849</td>
<td>1026</td>
<td>1879</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.543</td>
<td>0.457</td>
<td>0.134</td>
<td>1.397</td>
<td>1040</td>
<td>1904</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0.349</td>
<td>2.489</td>
<td>1170</td>
<td>2138</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>0.429</td>
<td>4.008</td>
<td>1200</td>
<td>2192</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0.401</td>
<td>0.806</td>
<td>1290</td>
<td>2354</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>0.395</td>
<td>2.012</td>
<td>1350</td>
<td>2462</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contact:

I welcome your questions and comments.

Bob Magnuson
dulusion@gmail.com