Molecular Unity Formula or Seger Formula

This is a method of deriving the oxide amounts from a glaze recipe. It uses the relative weights of all the atoms that are in the fired glaze and organises how many there are of each sort relative to one another. It is important to note that the molecular formula is an abstraction that is based on what actually happens. So in a molecular formula it is common to talk about fractions of molecules, when in reality that isn't possible, but the important information isn't about the absolute numbers of molecules in a glaze (which would be countless billions) but rather the relative numbers of each.

To start the process, first list the ingredients:

(for our example we will be using the Leach Limestone glaze)

Potash Feldspar	40
China Clay	10
Whiting	20
Silica	30

Next we find the list of oxides that makes up each ingredient and what its molecular weight is. Molecular weight isn't an actual physical weight, instead all the atoms are ranked from lightest (hydrogen) to the heaviest (Copernicium), hydrogen was given the molecular weight of 1 and the weights of all the other elements are expressed in terms of their relationship to the weight of the hydrogen atom. For example the atom oxygen is sixteen times as heavy as hydrogen so its atomic number is 16. The molecular weight of a material is just the sum of all the atomic weights that make up the material's formula. So for a material like china clay with the formula;

$Al_2O_3.2SiO_2.2H_2O$ the weights are added up like this;

Al = 27 X 2 = 54
O = 16 X 3 = 48
Si = 28.1 X 2 = 56.2
O = 16 X 4 = 64
H = 1 X 4 = 4
O = 16 X 2 = 32
Total = 258.2

Now we layout the glaze recipe using the above information:

Material	Formula	Amount	Molecular Weight	Calculated Molecular Weight
Potash Feldspar	$K_2O.Al_2O_3.6SiO_2$	40	÷ 556.8	= 0.0718
China Clay	$Al_2O_3.2SiO_2.2H_2O$	10	÷ 258.2	= 0.0387
Whiting	$CaCO_3$	20	÷ 100.1	= 0.2
Silica	SiO_2	30	÷ 60.1	= 0.499

Next we multiply the individual oxides in each material by the calculated molecular weight (C.M.W.) of the whole material. At this stage we can discard any molecules that will be vaporised by the kiln when heating up, these molecules are chiefly water (H_2O) and carbonates (CO_3):

Material	C.M.W.	K_2O	CaO	Al_2O_3	SiO_2
Potash Feldspar	.0718	.0718		.0718	6x.0718=.4308
China Clay	.0387			.0387	2x.0387=.0774
Whiting	.2		.2		
Silica	.499				.499
TOTAL		.0718	.2	.1105	1.0072

Now we list these numbers under the various oxide groupings. From this point on we have discarded the idea of materials and are solely working with various quantities of oxides. We group the various oxides under headings as already explained, we also group them using a system that refers to the amount of oxygen present in the molecule. So all molecules that have only one oxygen go under the R_2O group (the R stands for radical or any atom), these are also usually fluxes or opacifiers. Molecules with three oxygens for every two other atoms are under the R_2O_3 group and thought of as stabilisers. The last group is for molecules with two oxygens for every other atom, RO_2 and are the glass forming oxides.

Fluxes (R_2O)		Stabilisers (R_2O_3)		Glass Formers (RO_2)	
K_2O	.0718	Al_2O_3	.1105	SiO_2	1.0072
CaO	.2				
Total	.2718				

This is now a molecular formula. However to be more useful and to comply with the accepted ceramic industry norm we perform an additional calculation that makes the first column equal one, hence the term Unity Molecular Formula. We do this by dividing each amount by the total from the flux column (R_2O):

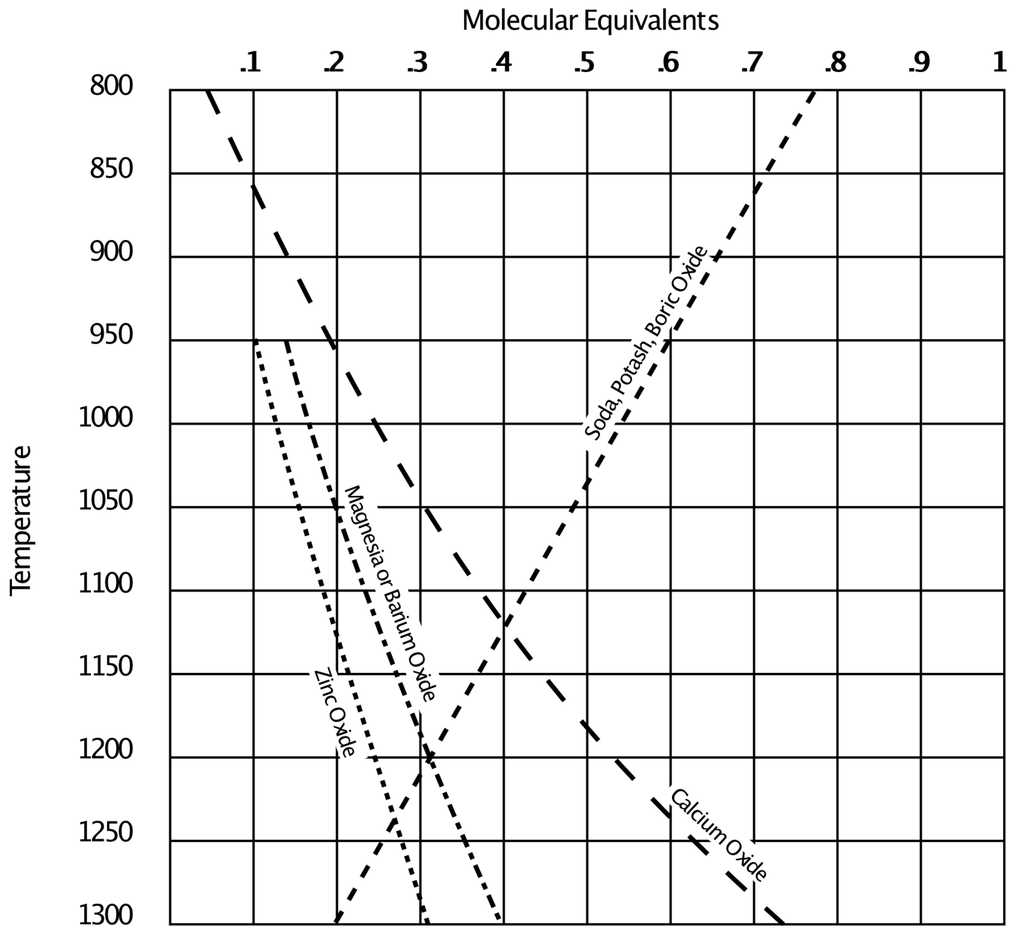
Fluxes (R_2O)		Stabilisers (R_2O_3)		Glass Formers (RO_2)	
K_2O	.264	Al_2O_3	.406	SiO_2	3.7
CaO	.736				

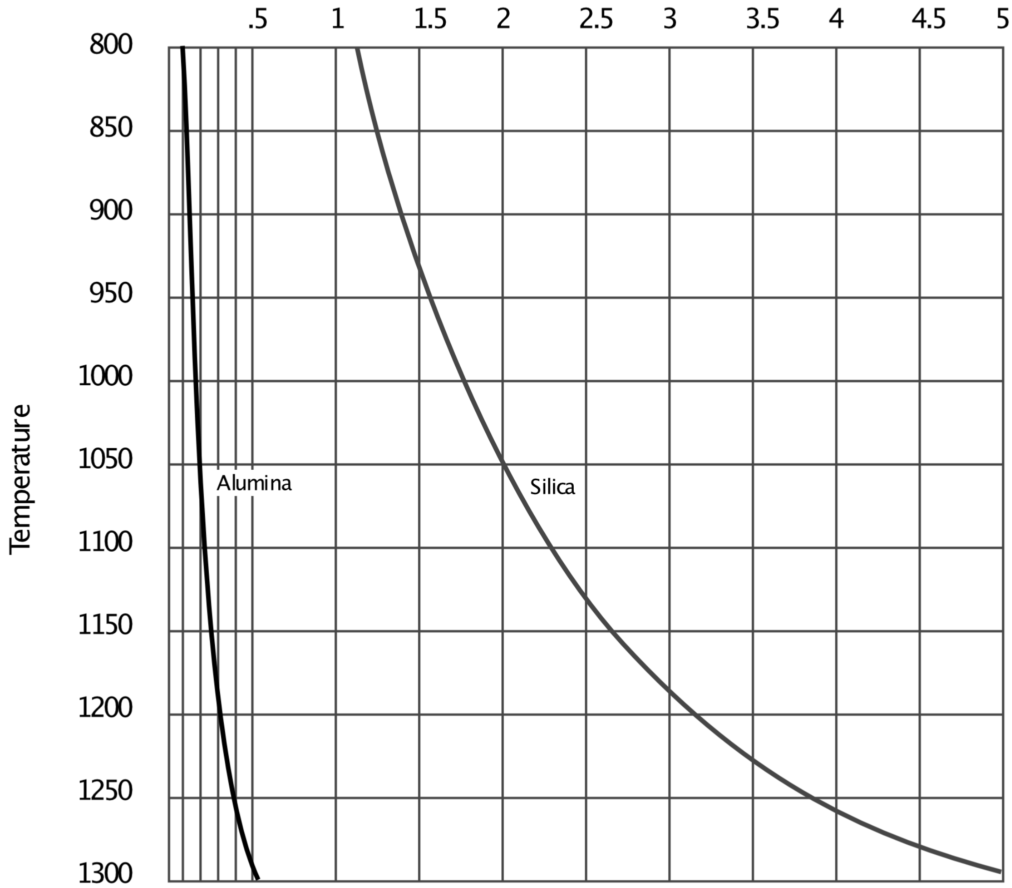
From this we can now derive the important ratios.:
Silica:Fluxes Ratio = 3.7:1
This is the correct amount of silica for a cone 8 glaze when using limit charts

Silica:Alumina Ratio = 3.7:0.406 or to simplify we divide each side of the ratio by the alumina figure
E.g. 3.7/0.406=9.1, 0.406/0.406=1, so the ratio is 9.1:1
This ratio would put the glaze in the glossy end of the spectrum.

Flux Ratio = Alkali .264:Akaline Earth .736
Indicates the glaze has the correct balance for a high temperature glaze.

We have a tool called limit charts that are very useful for analysing a glaze once it's in the Unity Molecular Formula. These have been worked out for various temperatures and list the optimum amount for any oxide. It is important to note that the effects of combining various oxides can produce unexpected results even when using these charts. Also they are designed only to provide a shiny stable glaze, if you want a satin or matte finish then you will need to depart from the limit charts to achieve this.


Molecular Equivalents
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
800
850
900
950
1000
1050
1100
1150
1200
1250
1300
Temperature
Soda, Potash, Boric Oxide
Magnesia or Barium Oxide
Zinc Oxide
Calcium Oxide


.5
1
1.5
2
2.5
3
3.5
4
4.5
5
800
850
900
950
1000
1050
1100
1150
1200
1250
1300
Temperature
Alumina
Silica