

## The Formulation Process

*(First in a series)*

When creating a personal care product you are faced with the choice of making a recipe or using a formula. What's the difference?

A recipe is generally considered to be a list of ingredients using kitchen measures that makes only one size of the product. The use of the kitchen measures is not particularly accurate and can lead to significant differences when the product is either remade or scaled up in size. When scaling a recipe you have to work with fractions and the simplification of complex fractions like figuring that  $\frac{4}{3}$  cups is  $1 \frac{1}{3}$  cups of an ingredient or that 5 tsps is 2 tbs and 1 tsp of an ingredient. Then there is the issue of drops. Depending on the dropper that is used this can vary greatly and they are not linear measurements. Depending on how the material settles in the measuring device the quantity can vary plus or minus. For making a cake or cookies this may be acceptable but when making a personal care product the results can be disastrous. Too much or too little of an ingredient due to faulty measure can render the product unstable or worse.

A formula is a listing of ingredients and quantities based on a total of 100%. The ingredients are weighed using a scale or balance instead of using measuring cups and spoons. The accuracy and reproducibility is greatly increased and scaling from one size to another is easy. To scale a product that is written as a formula all that is needed is to multiply the desired quantity of product (batch size) by the percentage of the formula that the ingredient comprises and then weigh that amount. The most common unit of measure is the gram. There are 28.35 grams per avoirdupois ounce. Note that this is not the same as a fluid ounce. The former is a unit of mass while the latter is a unit of volume.

Now that we have talked about formulas you may ask how I convert my recipes to take advantage of the ease that a formula provides to the formulator. This is a relatively simple process. Since recipes generally base their measurements on volume then you need to know some conversion factors. There are several websites that provide conversions for you. These include:

<http://www.onlineconversion.com/>

[http://www.processassociates.com/process/convert/cf\\_all.htm](http://www.processassociates.com/process/convert/cf_all.htm)

You can also do the conversions yourself using the following constants:

1 ounce=28.35 grams

1 fl oz=29.57 ml

Because of the different densities of the raw materials used in personal care products converting a recipe to a formula will give you a close approximation of the formula. Once you have this approximation then you can begin to work only in mass and refine your formula. Therefore if a recipe calls for a 'pint' of an ingredient then you would note that a pint is 16 ounces times 29.57 ml=473.12 ml. One fl oz =2 tbs therefore 2 tbs =29.57 ml. For many practical purposes knowing that you will be refining the formulation you can assume that 1 fl oz = 1 avoirdupois oz. The exception is when you are converting the oils used in a recipe to mass. Here you will need to assume that the oil weighs approximately 80% of the original conversion. This is because oils have a lower specific gravity than

water which is the basis for much of our conversions. Therefore one pint of an oil would not weigh 453 grams but approximately 362 grams. To obtain a more accurate conversion of volume to mass it is necessary to know either the density or the specific gravity of the substance that you want to convert. Density is defined as the mass of the substance per unit volume. As an example the Density of Water is 8.32 pounds per gallon. Specific gravity is defined as the ratio of mass of the substance to the mass of an equal volume of water. Therefore the specific gravity of water is 1 since you are comparing the mass of a given volume of water to the mass of the same volume of water. Knowing the specific gravity, abbreviated as Sp. G., you can multiply the Sp. G. of the substance times 8.32 which is the density of one gallon of water at 20°C to determine the weight of one gallon of the substance.

Once you have converted the volumes of each ingredient in the recipe to a mass in grams you are now ready to begin writing the recipe as a formula. To begin arrange the ingredients into your water phase materials and the oil phase materials. List each material and the weight it contributes to the recipe to the right of the material. Next total the weight of all the materials in your list. This is the weight in grams that your recipe makes. This is the batch size. Now for any ingredient in your recipe divide the weight of that ingredient by the batch size and multiply by 100. This gives you the percentage of that material in the formula. Enter that percentage to the right of the ingredient next to the weight you entered previously. You will do this for each ingredient. When you are done, you will have three columns, the first column is the ingredient, the second is the weight of the ingredient in the recipe and the third is the percentage. Now sum up the total of all the numbers in the third column and it should equal to 100%. Due to rounding it may be off slightly. In that case make up the differences in the largest ingredient which is usually water. See the table below for a simplified example:

Ingredient	Measure	Weight	Percent
Water	2 quarts + 1 pint	2265	62.4
Glycerin	1/2 cup	113.4	3.12
Triethanolamine	4 tbs	59.2	1.63
Water	1 2/3 cups	378.8	10.44
Ultrez 10	3 tsp	18.1	0.5
Stearic Acid	1/2 cup	113.4	3.12
IPM	2 1/2 cups	567	15.62
Cetyl Alcohol	1/3 cup	74.8	2.06
Germaben II	2 tbs + 2 tsp	40	1.1
<b>Total</b>		<b>3629.7</b>	<b>99.99</b>
		3628	
1 quart=907 grams			
1 pint =453 grams			

1 cup=226.8 grams

1 tbs=14.8 ml

1 tsp=5 ml

1 ml=1 gram

In the example above I calculated this backwards using percentages for a lotion and based the batch size on one gallon which is approximately 3628 grams. You will note that the weight of the ingredients actually is 3629.7 grams based on the conversion factors listed at the bottom left. This is an example of the inaccuracy possible from using kitchen measure. If you have a formula and you want to make one gallon of product knowing that a gallon weighs 3628 grams then you would simply multiply the batch size, 3628 grams, by the percentage listed in the last column for the amount that you need to weigh to make one gallon.

In the next issue of the newsletter we will continue discussing formulation basics and the types of raw materials used and their functions.

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