Preparing Hydroponics Nutrient Solutions, From Concentrations to Weights

In a previous post, I explained how concentrations are given in hydroponic gardening and what they actually mean. For example, I exemplified that 200 ppm of N equals a solution which contains 200 mg per liter of nitrogen although the form in which nitrogen is present is not described by the concentration data. In this post, I intend to explain how nutrient concentrations can be translated adequately to a mass weight of a certain salt that will be the actual source of the nutrient.
Let us start by supposing that you have a certain solution recipe given in concentration data, for example, the solution demands 200 ppm N and 700 ppm K (this is just an example as 700 ppm of K is too high for any hydroponic nutrient solution). This means that the solution requires 200 mg per liter of nitrogen and 700 mg per liter of potassium. Our mission now is to translate this concentration information into the actual amount of a given salt that needs to be weight and dissolved.
The first thing we need to do is find a suitable salt or salts that can give us the nutrients we want in the appropiate forms. In this case, we will use potassium nitrate (KNO_3) as a source of both nitrogen and potassium. This salt gives the plant nitrogen as $NO_3(-)$ ions and potassium as K(+) ions.

Our next step is to figure out how much solution we want to prepare. In this case, let’s suppose we want to prepare 100L (around 32 gal) of nutrient solution.

Following this, we must calculate how much much K(+) and how much $NO_3(-)$ need to be added in order to achieve the concentrations we desire. Since K(+) contains a single K atom, we need 700 mg/L of K(+) in order to achieve 700 ppm of K, for the nitrate ion ($NO_3(-)$), since it contains more atoms, we need to know how much of the nitrate ion is actually nitrogen. In order to do this we calculate what fraction of nitrogen resides in nitrate by relating their molar mases (you can google nitrate molar mass and nitrogen molar mass to get this values or calculate them using your periodic table) . The calculation would be 14/62 which equals 0.22. This means that 22% of each nitrate ion is nitrogen. If 22% of each nitrate ion is nitrogen then we need 200ppm x(100/22) of nitrate in order to get the concentration of nitrogen we want. The result is that we need 909 mg of nitrate per liter in order to achieve our required concentration of 200 ppm.

Since our salt is KNO_3 and not K or NO_3 by themselves we need to decide which nutrient we want to fit in an exact manner. For this example I will take $NO_3(-)$. Since we want to weight 909mg per liter of $NO_3(-)$ we see how much KNO_3needs to be weight in order to achieve this amount for 100 liters. For this we use the relationship between the molar mases of nitrate and the salt, potassium nitrate. The equation is 62/101, which equals 0.61, meaning 61% of potassium nitrate is nitrate. Since we want to know how much is 100% knowing that 61% is 909mg per liter we calculate 909ppm x 100/61, which equals 1490mg per liter which needs to be multiplied by 100 in order to find the amount needed for 100 liters of solution. The final result is that 149 g of potassium nitrate are needed in order to achieve a concentration of 200 ppm of N in 100 liters of solution.

Now what happened to the potassium ? Since we added potassium nitrate, we also added potassium with the salt. We now need to calculate the concentration of potassium which we get when we arrive at a concentration of 909 ppm for ntirate. Since we know nitrate is 61%, then potassium must be 39% of the concentration so 1490 ppm x 0.39 equals 581 ppm.

As you can see, we matched our nitrogen requirement perfectly but ofset our potassium requirement by an important amount. This problem is due to the fact that each salt gives two nutrients to a soltuion. Meaning that a good salt combination needs to be used in order for our errors to be reduced when preparing the hydroponic nutrient solutions. This problem can be solved by using the hydroponic nutrient solution calculator I described in an earlier post, however, it is important to know how the calculator works in order to understand its possible errors.

As you can see, preparing nutrient solutions and turning concentrations into weights can be a little bit daunting at first but with practice and the aid of calculator tools, the preparation of custom hydroponic solutions becomes very easy and paves the way towards major improvements for any commercial or hobbyst hydroponic gardener.