Truly Cleaning Your Hydroponic System : The Fenton Process and Chemistry

When most people clean their hydroponic systems they use a hypochloride or hydrogen peroxide wash that they think kills all the bacteria and potentially hazardous substances within their setup. However few people realize that – although the system is indeed sterilized – the bast amount of harmful substances and chemicals (even those coming from the plastics themselves) remain intact after the attack of either hypochloride or peroxide. For example, many of the harmful plasticizers and complexes used for the making of PVC and other polymers remain intact after a rigorous wash with these two cleaning agents. So what can we do to truly clean our hydroponic systems and get rid of all the bad things that may be quietly waiting their turn to get into our plants ? The answer comes in the form of a very well known process used world-wide to clean water supplies from toxic chemicals : the Fenton process.

In the late 19th century, Henry John Horstman Fenton discovered a chemical process which was able to oxidize the most resilient organic molecules and turn them into harmless chemicals. As a matter of fact, Fenton's process was so revolutionary that it sprouted a whole new area of research called Fenton chemistry in honor of its discoverer. What was this wonderful discovery ? Within the next few paragraphs you will learn what the Fenton reagent and process are all about and – most importantly – how this process can help you clean, I mean REALLY clean, your hydroponic system between growth cycles.

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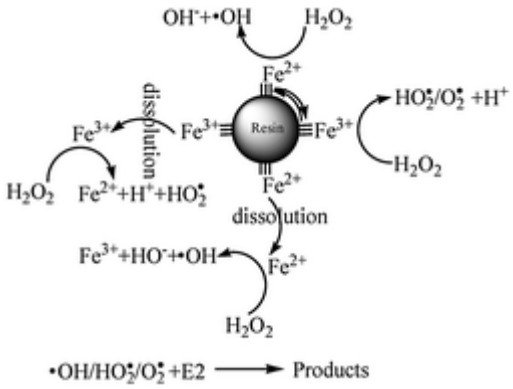

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If you have been preparing your own hydroponic solutions and you have been using hydrogen peroxide then you already have most of the things you need to do some Fenton chemistry. The process basically works by adding a source of iron ions (they must NOT be chelated, like iron (II) sulfate) and hydrogen peroxide to a water solution. The iron ions then catalyze a series of reactions that generate powerful oxidizing radicals that destroy almost all harmful organic substances within your system. The iron ions are KEY to the Fenton process since they allow peroxide to generate this extremely reactive substances that are never present when peroxide exists on its own (reactions shown above). Research has found – for example – that phenol (a common chemical used as a model contaminant) remains unchanged in the presence of large concentrations of hydrogen peroxide while it is quickly destroyed in the presence of the Fenton reagent (Iron ions plus hydrogen peroxide). So what do you need to do ?

- First of all you should add about 0.2g of Iron (II) sulfate per liter of solution you will be using to clean your system.
- Then you should set your pH to a level between 3 and 3.5 using a STRONG non-organic acid such as nitric or sulfuric acid. You should NOT use citric, acetic or phosphoric acids since they lower the effectiveness of the Fenton reaction.
- Add as much peroxide as you would add to regularly clean your system. About 70mL of 50% hydrogen peroxide for each liter of solution works very well.
- Circulate the Fenton cleaning solution for at least 6

hours.
- Wash your system with water until no Fenton solution remains.

It is key for you to use a non-chelated iron source since chelated iron sources such as FeEDTA or FeEDDHA do NOT work well since the chelate does not allow the iron ions to properly react and participate in the Fenton chemistry that should be going on. The pH adjustment step is also vital since a pH above 5 would cause the formation of FeOH3 instantly upon the addition of H2O2 with the subsequent catalytic decomposition of all the H2O2 by the iron hydroxide (this is NOT something we want !). After you use the Fenton reagent to clean your system you will be certain that a lot of the harmful organic molecules that were present have been destroyed and your system will now be able to play as a sterile and harmless host to your new set of beautiful plants.

Iron Sources in Hydroponics : Which One is the Best ?

Definitely one of the most important problems dealing with the stability of hydroponic solutions is the availability of the iron (Fe+2 or Fe+3) ions. Since iron easily forms hydroxides and insoluble salts with other ions present in hydroponic media it becomes essential for us to provide iron in a way which is accessible to the plant and does not “come out” of the hydroponic solution through precipitation. Within the next few paragraphs I will talk to you about different iron sources available to hydroponic growers and which source is actually the best one we can use in hydroponic nutrient solutions. We will go through the different factors that make an iron source better or worse and finally we will be able to choose one as the ideal source for our nutrient needs.
What is the problem with iron ? The main problem we have with iron is that – unlike most other transition metal ions in

hydroponic solutions – it is a very strong hard lewis acid which easily forms insoluble salts with many of the hard lewis bases within our hydroponic solutions. When iron is added to a nutrient solution in its "naked" form (for example when adding iron (II) sulfate) the ion easily reacts with carbonate, phosphate, citrate, oxalate, acetate or hydroxide ions to form insoluble compounds that make the iron effectively unavailable to our plants. To put it in simpler terms, iron ions have a chemical nature which is similar but opposite to that of many other constituents of our hydroponics solution meaning that when they meet together they form a "perfect match" that does not easily separate.

There is not only a problem with the higher inherent chemical match-making of iron with the anions present within the solution but we also have the problem that iron is always present at a much higher concentration than the other micronutrients. So even though some transition metals like copper would suffer from similar problems the fact is that they do not simply because of their much lower concentration (Fe is usually around 3-5 ppm while Cu is usually around 0.05-0.01 ppm).

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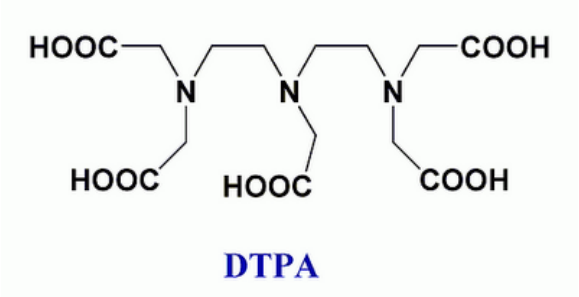

DTPA

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The solution to this problem is actually easy and comes in the form of chelating agents that "wrap" around the iron ions and make them disappear to anions that may want to form stable salts with them. There are many of these chelating agents with the most commonly used being EDDHA, EDTA and DTPA. They are different due to the fact that their stability is different and their abilities to dissolve iron are also different. While all of them make sure iron stays within solution EDTA only allows this to happen until pH 5-6 while, DTPA takes it until about 8 and EDDHA to more than 9. The most stable iron complex

is definitely FeEDDHA but this does not make it necessarily the best candidate for hydroponic growing.

The fact is that although EDDHA binds iron much more strongly it decomposes easier within the hydroponic solution than EDTA or DTPA (this is due to the fact that EDDHA is composed of several different isomers, some of which are not very stable), reason why this complex appears to be but is not the best solution for hydroponic nutrient solutions. The best compromise between stability and durability is earned by DTPA which gives us a very stable complex and a strong resistance to decomposition. So next time you are looking into getting a new complex for your Fe needs, try FeDTPA (this salt can also be used with my hydroponic calculator).