Frequently Asked Questions

What is Conductivity?

When salts dissolve in water they produce an electrically conductive solution, absolutely pure water does not conduct electricity.

The more mineral salts dissolved in water, the more the Electrical Conductivity (EC)
We can measure this electrical conductivity with a conductivity meter; these meters are calibrated to read in several different units.
ppm; TDS; CF; EC; Siemens, Millisiemens, Microsiemens.

ppm, Parts per million.
TDS Total dissolved salts. (Just another way of saying ppm)
CF, Conductivity factor.
EC, Electrical Conductivity.
Siemens (Mho)
Millisiemens. (mS or mMho)
Microsiemens. (uS)

How are these related to each other?
Scientific meters usually use, the Siemens, Millisiemens or Microsiemens units.
1 siemen = 1,000 Millisiemens = 1,000,000 Microsiemens.

Commercial horticultural meters usually use either EC or CF
1.0 EC units = 10 CF units = 1.0 Millisiemens

Hobby grower meters can be either, EC, CF, ppm (or TDS)
Ppm is calibrated in parts per million, that is 1 ppm = 1 part of an item in 1million parts of another item.
For example; 1 gram of minerals in 1,000,000 grams of water (1000 liters) = 1ppm (or TDS)
1000 TDS (ppm) = 15 (mMhos) EC for Sodium Chloride solutions.

Minerals other than Sodium Chloride can have a different EC reading for the same 1000 DTS, this is because some salts conduct electrical current better than others, Sodium Chloride at 1000TDS is actually 8400ppm, but Calcium Carbonate at the same reading is 7250ppm
A nutrient solution contains a wide number of different salts, the mix of these however remain constant for many crops, and small changes in nutrient formulation do not make a large difference in EC reading, at the same ppm.
Examples of different EC reading at 0.2% solution strength are;
Calcium Nitrate 2.0 EC (20 CF)
Potassium Nitrate 2.5 EC (25 CF)
Potassium Sulphate 2.4 EC (24 CF)
Magnesium Sulphate 1.2 EC (12 CF)
Mono Potassium Phosphate 0.9EC (9 CF)

Changes in the temperature of the solution being read will alter the Electrical Conductivity of that solution, for this reason it is essential to buy a meter that has automatic temperature compensation of its readings. Usually all readings are converted to 25 degrees C, as the standard. The temperature compensated meter probes have a thermister in the probe to read the temperature of the solution, this is then used to automatically correct the reading being shown, it is necessary to stand the probe in the solution for a few minutes to allow the probe to reach the same temperature as the liquid being tested.
Temperature conversion factors for non auto compensating meters are;

^{o}C	^{o}F	Temperature factor.
5	41.0	1.613
10	50.0	1.411
15	59.0	1.247
20	68.0	1.112
25	77.0	1.000
30	86.0	0.907
35	95.0	0.829
40	104.0	0.763

How do we calibrate conductivity meters?

Standard solution to calibrate instruments are made with Potassium Chloride salt, at a given ppm, or EF (CF) reading, these are used to calibrate the meter at a given temperature, usually 25 degrees C.
Most meters will have an adjusting screw, or may even have a calibration mode, especially on automatic nutrient dosing equipment, follow the manufacturer's instructions for calibration of these units.
Immerse a clean probe (clean and dry off probe to avoid contaminating the standard solution) in the standard solution, wait for two minutes to allow the probe to reach the same temperature as the solution, this gives a temperature corrected reading, then adjust the meter to read to same as the standards solution conductivity.
Cleaning probes is easily done with common household cleaners, but beware, don't use any that have Lemon scenting or similar, as the oil from the lemon will stay on the probe giving an incorrect reading.
Rinse the probe in clean clear water, and shake off the surplus water before immersing in the standard solution.

What is pH.? And how does it control growth?

In Hydroponics pH is used as the measurement of acidity or alkalinity of the nutrient solution. The most important test of a nutrient solution is pH. The pH scale is from 0 to 14.

At 0 it's the most acidic, and at 14 it's the most alkaline, and at 7 it's neither acid or alkaline, it's neutral.
What we are reading is the Hydrogen Ion concentration, the pH is the negative logarithm to the base 10 of the Hydrogen Ion concentration.

To put it simply the scale is a mathematically derived scale, where pure water that is neutral is 7.0 and as the hydrogen Ion concentration increases either positively or negatively, the readings move from 7.0 towards either 0 or 14.0.

0 being the most acidic and 14 the most alkaline.

Plants can survive in the pH range 4.0 to 8.0 Below 4 there is a danger of the roots being damaged, and above 8.0 some of the minerals can be precipitated or are not available to the plants.
The ideal range for most plants grown in Hydroponics is from 5.8 to 6.5. We try to keep within this pH range at all times. Most automatic nutrient dosing equipment is set for 6.2 or 6.3pH and dosing is automatic.

If the pH is outside the range where plants can take up minerals, then it does not matter how good or bad the nutrient is in terms of dissolved minerals, the plants will starve to death, as some minerals cannot be taken up by the plant. Deficiencies are often seen in crops grown at the wrong pH even when the mineral balance of the nutrient is perfect.
See section of deficiencies.

We measure the pH of a solution with either a pH meter, or a pH tape.
pH tapes are not as accurate as the meters, but can be cross referenced by placing in a pH standard solution to check they have not gone off, or been contaminated.

The pH meter is calibrated using buffer solutions, and from the pH test reading we either have to raise the pH or lower the pH of the nutrient solution.
When plants are growing in good light and warm conditions the normal trend is for the pH to rise, and we have to add a pH lower (acid solution).
In cool, dark, short day conditions, it's normal for the pH level to fall and we have to raise the pH. Add pH raise (alkali solution)

To lower the pH we use an acid.
To raise the pH we use an alkali.

pH controls the growth by making minerals in solution available to the plant, if the pH is incorrect, then the plants cannot take in all the minerals required to grow properly, and deficiency or toxicity symptoms can occur, at the worst, roots can be destroyed by the acidity of the nutrient, and plants die.

How do we calibrate pH meters?

Standard solutions, called buffer solutions are used of a known pH value; these don't last forever, and can easily become contaminated. Regular replacement with new solutions will avoid any incorrect pH nutrient levels, causing poor growth. These solutions are both inexpensive and readily available in small containers and bulk packs, the bulk packs are ideal to refill the small bottles after use, we recommend growers use the small bottles only once, replacing with new material from bulk supply for every test. Remember, meters or any automatic nutrient dosing unit is only as accurate as the standard used in calibration, if the solution is contaminated or has gone off, then the settings are out of calibration, this can lead to dramatic crop reduction. We have seen many growers struggle to grow good quality or quantity of crops, when it was just a case of an incorrect pH of the nutrient.
To maintain the ideal growing conditions in the nutrient for optimum growth is not hard, regular re-calibration of equipment is both necessary, and easy to do.

pH calibration should be checked every week, with most equipment it only takes a few minutes, and this time is more than paid back by increased production, quality and quantity.

A pH meter uses a pH probe to measure the Hydrogen Ion concentration in the solution.
pH probes are not a cheap item, but with careful use they can last many years, we have had units in use for up to 9 years in some cases, but the average is about 5 years before replacement. Drop the unit, or knock the glass bulb on the end, and it's broken, and a new probe needs to be fitted. Gel filled probes are quite suitable for horticultural use, and are much cheaper than the laboratory grade of unit.

To calibrate meters follow the manufacturers instructions, remember to carefully clean the probe before immersing in a standard solution, to avoid any contamination of the solution.
Adjust the meter using the adjustment screws, or mode for automatic dosing systems; adjust to the standard reading found on the standard solution container.

As a pH probe starts to age, it takes longer to reach out to the 4.0 or 10.0 pH standard solutions used, electronic adjustments to the equipment can make up for this aging, but in time all adjustment in the equipment will be used up, this then requires a new pH probe to be fitted.

When installing a new pH probe, it always pays to 'activate' the probe, by standing in a weak acidic/salt solution for a few hours before use. New probes can take about 10 minutes before stable readings are obtained, so if you have the time, activate the unit a day before use, this is not always possible, so if a new probe has to be fitted straight from the packet, remember to re-check the pH calibration in a couple of days, this will ensure the readings are corrected for any initial drift in readings.

What is Rockwool?

Rockwool is the most popular media used in Hydroponic production on a world wide basis, with more than 50% of the worlds Hydroponic production grown using this media, more than all other medias put together.

Rockwool was developed in Europe, using a very special manufacturing process of heating basalt rock (volcanic rock) the raw material, to a temperature of 1600 degree Celsius and a hot molten mass is ejected onto rotors, which spin at high speed. Often called the fiberization process, centrifugal force produced from the spinning rotors are then used to draw the fibers from the molten mass to produce a thick dense blanket. A phenolic agent is applied to bind the molten blanket together, followed by wetting agents and then cured in an oven to produce Rockwool.

Rockwool is sterile and is formed into blocks and slabs of many sizes to suit all plant types.

Why use re-circulating systems?

The world's resources are not limitless, oil, water and minerals are becoming scarce in some parts of the world. Re-circulating or closed systems are very cost effective as no nutrient or water is wasted, unlike run to waste systems where minerals and water are lost into the soil. Different systems can either run continuously such as NFT (Nutrient film technique) or DFT (deep flow technique) or intermittently such as flood and drain.

NFT, DFT, and flood and drain are known as high volume re-circulating systems.
Low volume re-circulating systems catch the run off from bag and slab systems, treat the run off and reuse it, making it more economical than the run to waste systems. Heating the nutrient in cool climates in any system is a cheaper way of producing plant growth than air heating, as less energy is required.

What is NFT?

NFT is the growing of plants, bare-rooted in long, waterproof channels, down which flows a very shallow stream of re-circulating water, into which are dissolved all the minerals required to grow healthy plants.

Who invented NFT?
The idea of NFT was conceived and born at The Glasshouse Crops Research Institute in the mid 1970's in England, lead by Dr Allen Cooper and his team of horticultural scientists.

Why was it thought to be necessary?
In the United Kingdom at that time most Tomato crops were grown in soil, with expensive heating to grow crops to yield results early in the season. The main competition came from Dutch growers, but with the advent of the EEC, other European producers were able to send cheaper produce to Britain all year round. The British glasshouse industry was under extreme financial pressure, and lobbied the government of the day to start research programs to find better and cheaper ways to produce their food requirements. Hence the work done at The Glasshouse Crops Research Institute was started.

What happened next?
'The Grower' magazine published in the UK, published an article in the mid 1970's on the then experimental NFT findings. The magazine found its way to New Zealand, where the local glasshouse industry had just received the horrendous news that the price of crude oil was about to increase by about 70%. Most NZ growers in the mid 70's used oil for heating, this was going to cause major cost problems for them, so the NFT report, claiming cheaper heat input was seen as a savior, even if it gave no increase in yields.

One of the largest greenhouse Tomato producers in the southern hemisphere at that time was PTO Growers in Auckland. They converted one of their many commercial greenhouses to the NFT system as described in the magazine. The results were to say the least very disappointing, but as there was no direct contact with the NFT inventors, they thought it must be something they were doing wrong, and started a few tests to see if they could get the system to perform as stated in the article. Many months later, and after many people had got together to sort out the many problems, they finally got it to work as it was intended.

The New Zealand horticultural industry took to NFT like the proverbial ducks to water, and within a few years over 50% of all tomatoes produced in glasshouses in NZ were in NFT or other types of Hydroponic systems. Other crops followed, Lettuce, Herbs and Strawberries, until today there are very few crops not grown in NFT, including many flowers.

Today we have a very strong NFT growing community, and additional work is ongoing to improve quality and quantity of produce grown.

What is Ozone & how do we harness it?

Ozone is a gas made up of three Oxygen atoms 0_3 it has long been known as a sterilizing agent, but was largely replaced by chlorine for water treatment now not completely in favor especially for Hydroponic production.

Ozone is created naturally by;

(a) The action of an electric charge on atmospheric Oxygen, e.g. lightning strike.

(b) By UV light on atmospheric Oxygen (forming the ozone layer).

(c) Artificially by the corona discharge method in which air, which is 20% Oxygen, is passed through a chamber and subjected to an electrical corona discharge.

The energy changes Oxygen from the stable 0_2 to 0_3 which is unstable and reacts with a variety of materials in returning to the stable 0_2 state. During this process it attaches one of its oxygen atoms to the material with which it is reacting, and it is this oxidation which is the most powerful way to purify water.

A special injector draws the ozone into the water to be treated and after it oxidizes the contaminants or pollutants, it reverts back to oxygen. This leaves pure, sterile water with a maximum dissolved Oxygen level. Because plants love Oxygen this is an important and beneficial aspect of the process. This is a magnificent way of eliminating diseases, and has many other applications. Ozone has the ability to destroy water borne soil fungi, pathogens, bacteria, viruses, coli forms and other diseases, plus hormone weed killers, destroying them completely.

Ozone can also remove Iron and Manganese from water supplies, treat run-off water for reuse, rinse residues from spray tanks, and sterilize soil and greenhouse equipment. One of its main attractions is that it does away with the need to use expensive and environmentally damaging fungicides and sterilizers.

Ozone generators have been installed in poultry, piggery and dairy farms. They are also used for removal of Iron and Manganese from water supplies, sewage treatment, air deodorizing and freshening, and for purifying drinking water. Some are being used in swimming pools, as a safe sterilizer, in place of Chlorine products.

The horticultural industry has not been slow in recognizing the advantages to growers, and many are now installed in the hydroponics industry, to purify the incoming water and to sterilize the nutrient solution in recycling systems. Even where water or nutrient is run to waste, orchid production for example, the benefits are enormous, no pathogens to attack the plants and algae spore removal from the base water means less blocking of drippers and sprinklers. The end result is highly oxygenated water, and plants love oxygen.

What is Pythium?

Pythium is the generic name for a large number of so-called water moulds or damp-off fungi.
Virtually all vegetables, ornamentals and herbs can be attacked by one or more species of Pythium, and once it attacks, damping-off diseases can rampage through a crop very fast. There are over 50 species of Pythium, and they are not called water moulds for nothing. They typically live in wet soils, and water contaminated by soil and rotting vegetation. In Hydroponic systems there are few if any natural enemies of Pythium, so once it gets going it has a free run. Which particular species that is present will depend on which crop is grown, and the temperature. In spinach for example, there is one specie for cool conditions, and different specie at high temperatures.

The Pythium fungus is sometimes visible as a profuse white cottony growth on affected parts of the plant, usually at the base of the stem- the first signs of damping-off in seedlings are a pinching of the delicate young stem, just below the seed leaves, causing the plant to topple over.
As well as the cottony growth we can see, there is also a lot more of it ramifying through the infected tissue, and it produces two kinds of spore, one designed for survival, the other for travel. They cannot be seen by the naked eye, or even with a hand lens.

The first kind of spore is called an oospore. It is the result of a sexual process. Spores rearranged genes are better adapted to attack new host plants, and become resistant to fungicides. The oospore has a thick wall and can survive in dry conditions for months or years, germinating when conditions become wet enough again. The other spore comes from a little bag, like a mini water balloon, hanging from the diseased tissue. In water, it bursts open at the top, or blows out another little bag, which bursts open to release numerous tiny spores called zoospores. These are equipped with a pair of beating, hair like flagella by which the zoospore swims towards a new plant surface, following a chemical pathway. Here they encyst and infect the plant tissue to start the cycle over again.

In mature plants the Pythium can be an insidious root nibbler, attacking the tiny feeder roots without any visible sign of disease, until the leaves suddenly flag and the whole plant collapses. This disease is known as sudden wilt. It requires a laboratory to confirm Pythium in the roots.
Throughout a plants life, root growth occurs in cycles; older roots die off, and new ones are formed continually. At times, vigorous root growth can produce a lot of mucilage visible as a dirty white mass in the root mat. Pythium loves this stuff, and uses it to feed on before making another onslaught on new roots.

Observant growers will have noticed that where there are large numbers of shore flies or fungus gnats, there may well be a lot of Pythium; but it is uncertain which comes first-the fungus gnat or Pythium. The fungus gnat larvae can live on a diet of oospores, a few of these will persist through larval stage to adult flying stage, and carry the infection to a new crop, and to other greenhouses.

Pythium are water moulds, so can be introduced from well water, stream water and reservoirs that catch water from ground runoff, Pythium spores are transported by water.

Once you have Pythium, control is not easy. There are proprietary fungicides available, but oospores are almost impossible to eradicate.
Avoidance is better than control, and a lot cheaper. Water can be treated by slow rate sand filtration, Ozone treatment, and a series of chemical treatments.
The ozone treatment of water supplies will not kill off the oospores in the plants roots in a Hydroponic system, as ozone is only active in water for 8 to 15 minutes after injection, so it will not pass completely around a Hydroponic system and kill off spores, as it usually takes more than this time to flow from tank to plant roots and back to the tank.

Fungicides will help to lower the spore count, and healthy plants will not be affected, but again if stress is put on the plants, from any of the following;
Swings in pH or CF of nutrients, high temperature, or low temperature, then the plants can again be infected, Pythium is an opportunist disease, waiting for the conditions to be ideal for plant stress, or damaged tissue, and it will attack. The optimum temperature for the growth of Pythium is between 20 and 30 degrees ‘C’ with a decrease in activity at both higher and lower temperatures.
The problem is that Pythium spores are naturally present everywhere on a worldwide scale in water, soil and vegetation. Strong healthy plants will develop some resistance to Pythium.