



# Aquaponic System Manual

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*Congratulations* on your purchase of **The Aquaponic System** by CropKing! You'll be pleased to know that every component in your system has been thoroughly tested and is made with the highest grade, professional quality materials. Your entire Aquaponic System has been pre-assembled prior to shipment to ensure the quality and completeness of your order. If, however, for some reason there is anything missing when it arrives, call our Aquaculture Department at the number listed at the end of this manual for immediate replacement.

**IMPORTANT: YOU MUST INSPECT YOUR ORDER BEFORE ACCEPTING DELIVERY FROM THE SHIPPER. NOTE ANY DAMAGE ON THE SHIPPING RECEIPT. CLAIMS FOR DAMAGE WHILE IN TRANSIT MUST BE MADE THROUGH THE SHIPPING COMPANY.**

## 200 Gallon Aquaponic System



# Section 1

# Assembly

# ASSEMBLY

**1. Tools:** To assemble your Aquaponic System you'll need a flat head screwdriver, a level and a pair of pliers.

**2. Location:**

- a) Your Aquaponic System will occupy a space about 5' wide and 14' long. It's best to have walking and working space on at least two sides.
- b) Make sure that the place you select for the Aquaponic System has a floor sturdy enough to hold it. It will have close to 350 gallons of water—that's about 2600 lbs!
- c) Your plants will need light, so put the plant growing bed (the Aquaponic Tray) near a good source of sunlight, such as next to a broad window or inside a greenhouse. An Aquaponic System set up indoors may need supplemental lighting which CropKing can provide. Please refer to the Accessories page at the end of this manual or to our CropKing catalogs for lighting fixtures.
- d) You'll want to be within reach of a water source. Refer to the section on Water in **Operations** for considerations about sources. A nice optional item is the low-profile automatic float valve (part number FLOV001); it uses a convenient garden hose fitting to keep the water in your Tank always topped off at the right height.
- e) One 115V electrical outlet is needed for the high quality air pump included with your system. You may need more outlets if you've purchased a water heater (part number AQUHEAT01), additional lighting, etc. as well. The outlet(s) must be properly grounded; a ground-fault-interrupt (GFI) circuit is strongly recommended.

**3. Components:** Remove all the parts from your Aquaponic System packaging and familiarize yourself with the names of the components.



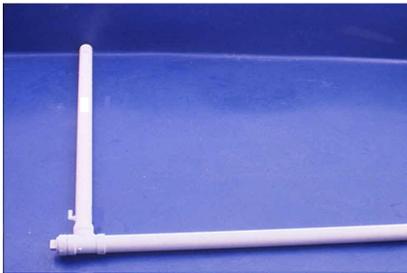
**Tank for rearing fish**



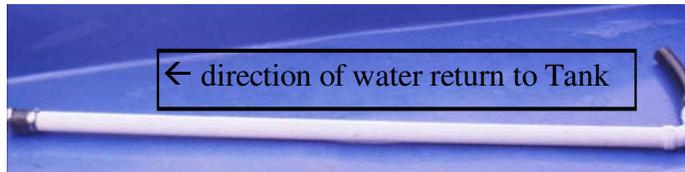
**Aquaponic Tray**



**Completed Airlift Water Pump Assembly**



**Outflow Assembly Part "A"**



**Outflow Assembly Part "B"**



**Valve Assembly (Gate and Ball Valves)**



**Inflow and Outflow Headers**



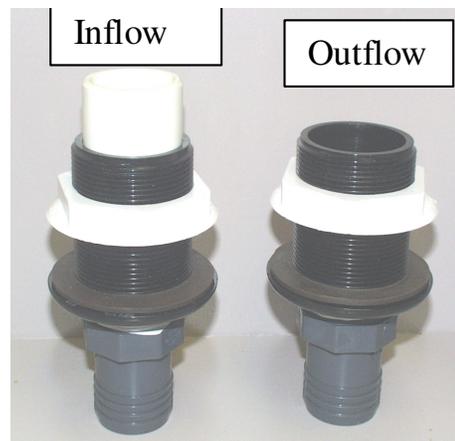
**Flow Hood Assembly**



**Optional Aquaponic Tray Stand, Plywood Underlayment comes with each system.**



**Air Pump and Stand**



**Bulkhead Assemblies**



**Air Hose Assembly and Air Pump**



**Air Ring Assembly**

#### **4. Assemble Drain and Stand for Fish Tank**

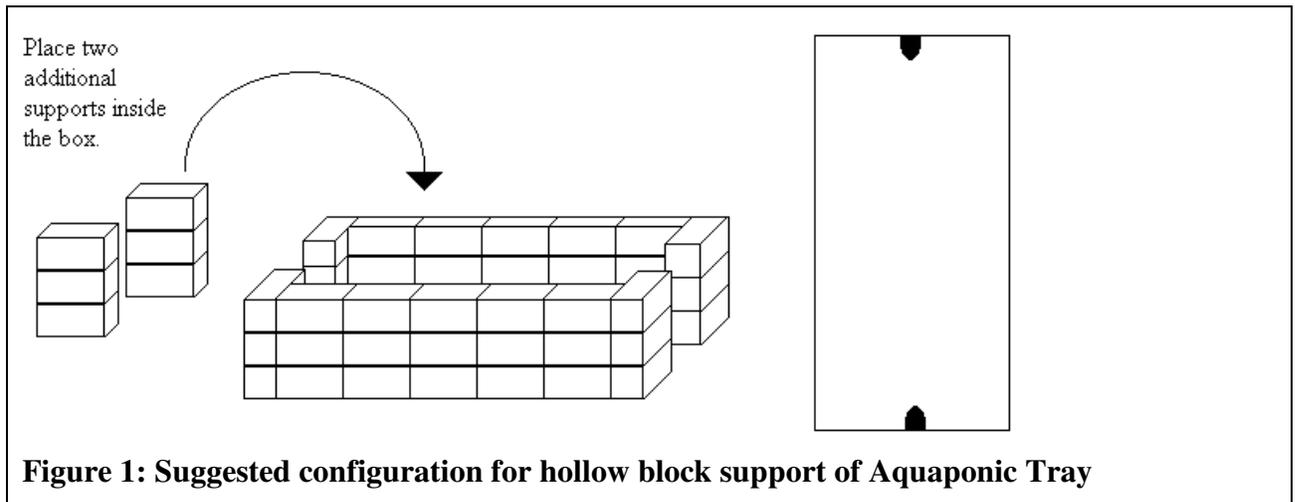
**( Note: If tank will not fit thru your door follow the below directions, otherwise skip to step #5)**

- a) Once you've decided where the Tank will be and which way the window will face, gently tip the Tank and Stand onto its side, being careful not to rest the window on the floor.
- b) There is a black poly tube attached to a gray barbed elbow in the bottom of the Tank. Using your screwdriver, loosen the stainless steel band clamp that holds the black poly pipe on the barbed elbow.
- c) Observe that there is a gap between the Tank Stand's supports that is larger than the others, and that the black poly tubing presently rests in this gap. When the re-assembly of this section is completed, the black poly tubing should again rest within this larger gap. Remove the tubing and set it and the Stand off to one side.
- d) Unscrew the retaining ring from the underside of the bulkhead fitting and remove the Barb/Bulkhead Assembly from the drain hole in the Tank. This bulkhead has reverse threads, so turn the retaining ring clockwise to loosen. Note that the rubber gasket is located on the inside of the tank, not on the under side.
- e) Make sure that the surfaces on both sides of the Tank hole, the gasket and shoulders of the bulkhead fitting are completely free from all dirt, dust and debris. Anything caught on these surfaces will create a leak, requiring draining the tank and doing it over. A few moments invested here really pays off.
- f) Apply a bead of silicone sealant (included) around the Tank's drain hole on both sides. Apply another bead of sealant to the flat side of the rubber gasket, then slide the gasket onto the Barb/Bulkhead Assembly with the gasket's flat side against the bulkhead's shoulder.
- g) Apply a thin bead of caulk onto the threads of the Barb/Bulkhead Assembly (this will provide lubrication and help ensure a snug fit).
- h) Insert the Barb/Bulkhead Assembly down through the Tank's drain hole and secure with the retaining ring. Make sure the elbow will be pointed towards to Aquaponic Tray when assembly is complete, and that when the Tank is set upright again that the Window will be facing in the correct direction.
- i) Firmly hand tighten the retaining ring. Too much force will squeeze the gasket out from under the plastic parts and leave a gap; snug and firm should do it. Remember, it's reverse threaded, so turn counter clockwise to tighten.

- j) Return the Stand back against the bottom of the Tank, inserting the gray barb down through the Stand's center hole and pointing the barb through the widest gap in the Stand's legs.
- k) Apply a light smear of silicone sealant to the barb and replace the black poly tubing, pushing as far up onto the barb as it will go.
- l) Secure by tightening the stainless clamp onto black poly tubing over the barb.
- m) Return the Tank and Stand to their upright position. Should the window seal become dislodged during this procedure or at any time in the future it can be resealed when completely dry using the included silicone sealant.

**5. Position the Aquaponic Tray**

- a) Place the Aquaponic Tray on the assembled optional Aquaponic Tray Stand (part number AQUHSTAND), or on another support. If using the specially designed Stand, check to ensure that the higher end is closest to the Tank. Regardless of the support you use for the Aquaponic Tray, it is important that the plywood supporting the Tray be level from side to side.
- b) You can make a support for the Tray by dry assembling 6" hollow block in the pattern in Figure 1, and then putting a sheet of 4' x 8' x 3/4" plywood on top of the stand. The plywood should have holes cut in both ends to accommodate the pipes coming out of the Aquaponic Tray.



**Figure 1: Suggested configuration for hollow block support of Aquaponic Tray**

The final height of a stand should be about 24 1/2" when level; it should measure 48" wide and 96" long on the outside dimensions. However, ideally, the Aquaponic Tray should rest about 2 inches higher (no more than three to four inches) at the end closest to the fish Tank. This is to facilitate gravity-assisted water movement through the Tray, and will optimize the overall function of the system. Should you decide to incorporate a

slope to your Tray stand, the end closest to the fish Tank, including plywood, will need to be no higher than 27". It's OK to carefully trim excess black poly tubing from the Drain Assembly if needed to help it fit under the lower end of the Tray.

## 6. Install the Aquaponic Tray Inflow

The Inflow takes the water from the bottom of the fish tank, past the drain and shut off valves and up through the Aquaponic Tray. It delivers the nutrient-rich fish water through a slotted header pipe.

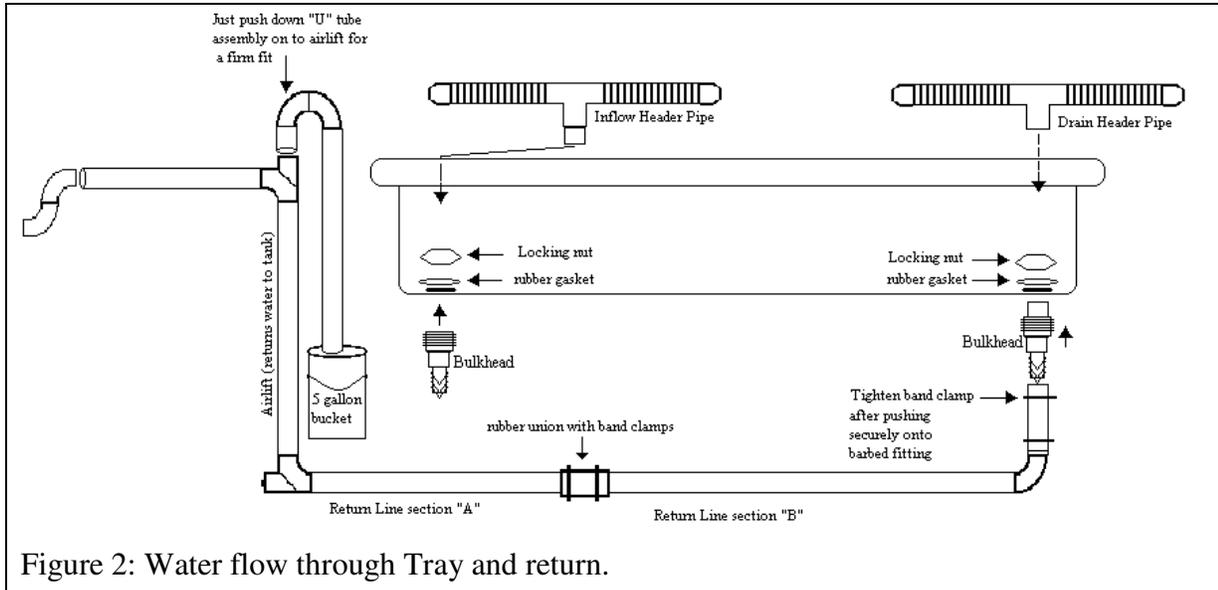


Figure 2: Water flow through Tray and return.

- a) The end of the Aquaponic Tray you place closest to the fish tank will be the Inflow end. Make sure that both sides of the Inflow hole are completely clean and free from all dirt and debris. Experience shows that even a small particle under a gasket can cause a leak! Check that the other surfaces are clean as well: the area on both sides of the Inflow hole in the Aquaponic Tray and both shoulders of the Inflow Bulkhead Assembly.



Figure 3: Apply sealant around shoulder of Bulkhead Assembly

- b) Take the rubber gasket off the Inflow Bulkhead Assembly. Note that one side of the gasket is flat and the other has a pair of ridges.
- c) Apply a bead of silicone sealant (included) to the flat shoulder or "lip" of the Inflow Bulkhead Assembly.
- d) Apply a bead of sealant to the underside and the bottom inside of the tray around the drain hole.
- e) Apply one more bead of sealant to the flat side of the rubber gasket (this is the "up" side). Put the

gasket with the *ridges facing down* over the drain hole (lining up the gasket hole over the drain hole).

- f) Insert the Inflow Bulkhead Assembly up through the hole in the Tray and hold it there while threading on the retaining ring. The seal should be made snug by only hand tightening the retaining ring—too tight will forcibly squish the gasket out of place and allow water to leak through. If you're not confident about the seal, we suggest running an additional bead of sealant around the edge of the bulkhead where it contacts the Tray. This would be done at the end of this section.
- g) Move the fish Tank so that its rim is about 13" from the rim of the Aquaponic Tray. The bottom of the Tank drains through a black poly tube—this tube and the elbow it comes from should point towards the Aquaponic Tray.
- h) Lubricate the gray barb of the Valve Assembly by putting a thin bead of silicone sealant around the tip of the barb.
- i) Slide the Tank's black poly tubing over the barb as far as it will go.

- j) Set the Valve Assembly on the floor—ensure that it will stand flat on the floor without any tendency to twist over to one side.



**Figure 4: Installing Valve Assembly**

- k) Using a screwdriver (or a nut driver), loosen the upper stainless steel band clamp on the Valve Assembly's black poly tubing.
- l) Lubricate the tip of the gray barb coming down from the Inflow Bulkhead Assembly with a smear of sealant.
- m) Push the black tubing up over the barb as far as it will go.
- n) Move the stainless band clamp over the barb, then tighten.

## **7. Install Aquaponic Tray Drain**

The Drain allows water from the Aquaponic Tray to return to the fish tank.

- a) Follow steps “a” through “f” in Section 6 for the Drain Bulkhead Assembly.
- b) Place the Drain Header onto the stem of the Drain Bulkhead Assembly and push gently but firmly down to secure in place. (No sealant or glue is needed for this joint.)



**Figure 5: Pressing Drain Header into Drain Bulkhead Assembly**

### 8. Assemble the Return Line

The Return Line joins the Drain to the Air Lift. It consists of two parts (“Return Line ‘A’” and Return Line ‘B’,” which are joined by a rubber Fernco union or “boot.” The union is secured in place by tightening 2 stainless band clamps.

- a) Lay the pieces flat on the floor (so that there will be no twisting in the final assembly).
- b) Loosen the stainless steel band clamp on the open end of the rubber boot.



**Figure 6: Assemble Return Line parts on the floor for flatness**

- c) Connect the two pipes by inserting the end of the open pipe into the open end of the rubber boot. Push the pipe in as far as it will go and re-tighten the loose band clamp onto the boot’s indentation.
- d) Put the completed Return Line under the Aquaponic Tray. The end with the black poly tubing will go under the Tray’s drainage end.
- e) Lubricate the gray barb of the Drain Bulkhead Assembly with a light bead of silicone sealant going around the barb. Push the black poly tubing over the gray barb until it’s seated as far up as it will go.
- f) Loosen the stainless band clamp and slide it onto the poly tubing over the barb. Tighten band clamp with the screwdriver until the clamp is securely in place.

### 9. Air Pump Stand

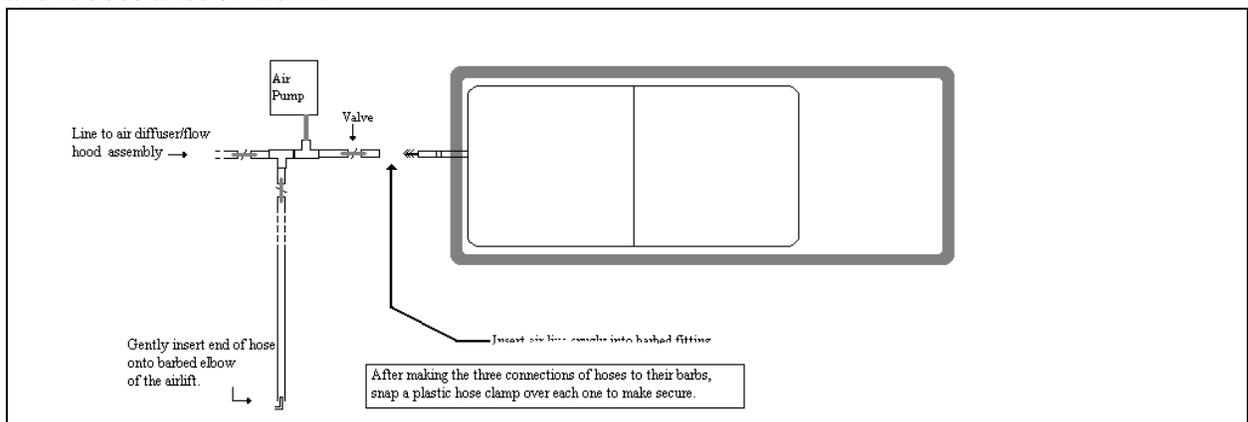
The Air Pump Stand holds your professional-quality Air Pump and Air Hose Assembly above the water level, helps keep the air adjustment valves within easy reach and serves to stabilize the pipes for the returning water flow.

- a) Your Aquaponic System's Air Pump Stand comes pre-assembled. One side has an aluminum band—this band slides over the top of the Airlift Pipe (the vertical portion of the Return Line). Place the Stand in the gap between the Tank and Tray. The aluminum band should be about in the middle of this gap.
- b) Lift the Stand slightly and slide the band down around the Airlift Pipe. This will secure the Airlift pipe in place.
- c) Place the legs of the Stand behind the Valve Assembly and Return Line to give easy access to the drain and cutoff valves.

## 10. Air Supply

Your Aquaponic System needs air for more than just the fish! The Air Ring for the Aquaponic Tray delivers oxygen to the plant roots and to the beneficial bacteria that live in your System's media.

Air is used to move water up through the Airlift Pipe and back into the fish Tank. Air bubbles rising in the fish tank are also used to help direct water flow in a circular pattern, which assists with solids removal. Your Pump is the only moving part in your System and it does a lot of work!



**Figure 7: Layout of the air supply lines**

a) The Air Ring arrives pre-assembled: just place it in the Aquaponic Tray with the vertical section of pipe located between the wall of the Tray and the Inflow Bulkhead Assembly.

b) Insert the Inflow Header pipe snugly into the top of the Inflow Bulkhead Assembly.

c) Place the Air Pump on top of the Air Pump Stand.

d) Take the Air Hose Assembly and slip the small stainless steel band clamp over the rubber hose. Push the open end of the rubber hose over the barb on the Air Pump.

e) Orient the Assembly so that the shortest hose points towards the Tank. Tighten the small stainless band clamp over hose on the barb of the Air Pump.

f) Take the end of the vinyl hose that runs off the tip of the Air Hose Assembly and *gently* insert it over the black barb near the bottom of the Air Lift pipe. Take care to support the bottom of the elbow as you push down; a little smear of silicone sealant on the barb helps to lubricate this. Clamp with a plastic “snap clamp;” use pliers to tighten clamp securely in place.

g) Insert vinyl tube nearest to the Air Ring onto its barb. Secure with “snap clamp” as well.

h) It may be worth noting here that the vinyl tubing, like each and every component in your Aquaponic System, has been selected with particular care. In the case of the vinyl tubing, it has extra thick walls to increase durability and reduce kinking. What makes this tubing especially well suited for this application, though, is that it was made without lead plasticizers—and that makes it far safer for use in your food production.



**Figure 8: The Air Ring and Inflow Header go into the Tray**

## 11. Protein Skimmer and Return Flow

Excess protein can be a source of potentially detrimental nitrogen for the fish. If the protein was not captured while passing through the Aquaponic Tray, it can be induced to form extra-large bubbles in the Airlift pipe. The bubbles formed by the stretching proteins tend to cling to the walls of the pipes and can be pushed out of the skimmer by the rising water and other bubbles forming underneath them. The removal of excess nitrogen in the form of protein helps in maintaining good water quality for the fish. Encouraging the formation and removal of these protein “bubbles” is a process known as “protein skimming.”

a) The last few pieces simply press into place. The Flow Hood is already bolted onto the rim of the tank. It should be located near the water return line (“Return Flow

Pipe") that comes off the top of the Air Lift. This is also another form of an airlift water pump. Again, rising air bubbles drive water from the bottom of the Tank up through the water column until everything hits the "ceiling" of the Flow Hood. Because of the Hood's slope, the movement of the air bubbles and rising water is directed laterally to help create the circular motion of water in your fish Tank. Note which way the Flow Hood is sloping: this is the direction you'll want to aim the flow of water returning from the Tray.

- b) Next, assemble the water return and skimmer piping: run a light bead of silicone sealant around the short end of the "U" shaped tube that facilitates protein skimming.
- c) Push the open end of the "U" tube onto the top of the "tee" that will, in a moment, go onto the top of the Airlift Pipe. When the installation is finished, the discharge end of the protein skimmer should be aimed into the 5-gallon bucket (included).
- d) Water re-enters the Tank via the Return Flow Pipe. Put a light smear of silicone sealant on the end of this horizontal pipe. That will aid in smoothing out the action of adjustment to the "S" that delivers the water back into the Tank.
- e) There are two elbows that form an "S" shape on the end of the Return Flow Pipe. Put these two elbows together and place them onto the end of the Return Flow Pipe. This "S" allows the returning water to flow back onto the surface of the fish tank with a minimum of splashing. Importantly, it also enables you to direct the water flow to assist in gently spinning the water in your round Tank. The circular motion of the water moves the dirt in the tank in towards the center, thereby facilitating removal of debris through the center drain.



**Figure 9: Push Return Flow and Skimmer pipes down onto top of Airlift pipe**



**Figure 10: Aim water outlet to encourage circular flow**

- f) The "tee" that joins the "U" shaped tube and the Return Flow Pipe should have a light bead of silicone sealant placed on the inside of the bottom rim.
- g) Insert the bottom of the "tee" onto the Airlift Pipe; aim the Return Flow Pipe into the fish Tank, keeping the end of the pipe about 5" from the inside edge of the Tank. The "S" should direct the water along but slightly away from the wall of the tank, as shown above.

## 12. Aquaponic Growing Media

Please read this section through before starting! Your Aquaponic System comes with substrate that will hold the roots of your plants in place while they grow. The seedlings will actually grow their roots right into this media to absorb the nutrients that the fish put into the water. There are fourteen bags of an inert, expanded clay media called Lecastone. There will be a little dust from emptying these bags into the Aquaponic Tray: we recommend wearing at least a dust mask to prevent inhalation. Four dust masks are included in your Aquaponic System kit for this purpose. Bear in mind that once the Lecastone has been wetted down it's no longer awkward to be around.

- a) Open each bag of Lecastone and pour it into the Tray. Make sure that the Air Ring remains on the bottom of the Tray during this process.
- b) When all the Lecastone is in, wet down the media by spraying water over the top. This will help eliminate any more dust from spreading. Drag the edge of a flat board along the surface to even out the media in the Tray.

### **13. Tank Prep**

- a) Take the blue, cone-shaped drain strainer and thread into drain inside Tank. It is designed for preventing the smallest fish from getting caught in the Tank's drain pipes. When your fish have grown beyond the point at which they could escape through the blue strainer, or if you stock with more mature fish, you may wish to remove the strainer or remove some of the bars to make the gaps wider. This will reduce clogging with the larger fecal material and improve flow characteristics.
- b) Read the notes on "Water Sources" in the Operations chapter, and you may then wish to start filling your system with water. As it fills, check carefully for leaks in each of the three bulkhead fittings.
- c) Fill your Aquaponic System so that water just comes up the edge of the inside shelf in the Tank, It may require more water to keep good lift and circulation. Even just a quarter inch more may do it, the key is to give the system time to circulate before adding more water. (**if the grow tray is not at the right height, this is usually the cause for bad circulation**) Refer to the Operations section of this manual about adjusting air flow through the valves and let water circulate overnight. You're done with Assembly!



**Figure 11: The completed Aquaponic System**



# Section 2

# System Operation



# OPERATIONS

This part of the manual provides an orientation to the nature of aquaponics and presents guidelines on how to maintain your system. As you read through this section, just bear in mind that it really boils down just to feeding the fish, replacing fish and plants as needed and monitoring water quality. While no manual could ever hope to cover every contingency for every individual's unique situation, details from many years of experience are distilled into these next pages to try to give you a feel for the techniques and particulars of growing aquaponically.

## I. System Basics

Your Aquaponic System is a complete ecosystem. That's because you're setting up a natural balance of animals and plants and the microbial community that links the two. Each one has its own role and thrives because it is an integral part of a larger whole.

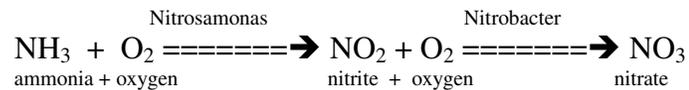
All animals make waste nitrogen in the form of ammonia. It is a metabolic byproduct that comes from the fish eating the food that you give them. The ammonia comes as a liquid and leaches from the solid waste as well. In the case of a closed system, where there is no new water constantly flushing the wastes downstream, ammonia can reach a high enough concentration to be toxic to the fish if it is not dealt with.

Plants need nitrogen for growth of green leaves—in the natural cycle of things animal waste and decomposing organic matter form the basis which plants can grow on. The whole process is mitigated by bacteria, which break down the waste and organics. In essence, the bacteria change the nutrients into a form that's better for the plants to utilize. In the Aquaponic System, we combine fish, plants and naturally occurring, beneficial bacteria to complete the circle of Life.

The following is a discussion of the main components in your Aquaponic System.

### 1. Bacteria, the keystone to it all:

- a) **How they work for you.** There are two naturally occurring kinds of aerobic (oxygen consuming) bacteria that work to help you raise fish. The first kind, *Nitrosomonas*, takes oxygen and the harmful ammonia and changes the ammonia into nitrite. Nitrite can also hurt the fish, but another bacteria co-exist with the first. *Nitrobacter* bacteria also use oxygen, changing nitrite into nitrate. (Nitrate is harmful to fish only in concentrations so high that they are rarely seen.) So the bacteria have detoxified the nitrogen in the system. They've also performed another function, which is to make nitrate, a far more "friendly" form of nitrogen to the plant roots than ammonia. This natural biological process can be roughly described as follows:



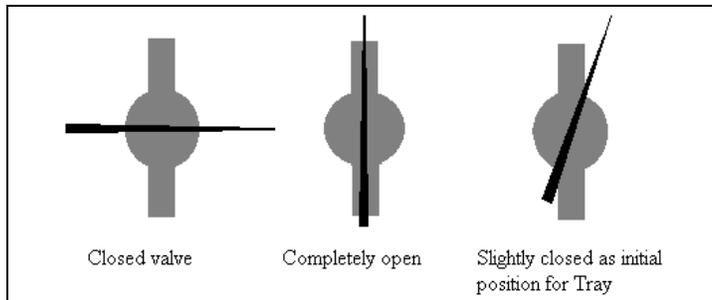
This process is called “nitrification,” and it is facilitated by a “biofilter.” “Bio-” meaning “living,” and “-filter” meaning “purify” or “separate.” By providing surface for your bacteria to live on, you have made a biofilter. The beneficial, autotrophic bacteria, *Nitrosamonas* and *Nitrobacter*, will colonize on all surfaces, e.g., the growing media in the Aquaponic tray, the tank walls, etc. After the first month or so you should be able to feel that the walls inside the tank and tray are slippery. That’s your beneficial bacteria! The vast majority of your beneficial bacteria will live on the Lecastone in the Aquaponic Tray. Without the surface area and bacteria to live on it, the Tank would normally sustain 5-10 lbs of fish. With the enormous surface area on the Lecastone, the Aquaponic System can grow up to 100 lbs of fish, and *that’s* the benefit of using a biofilter.

- b) **How to treat them right.** It’s important to provide the bacteria with an appropriate living environment:
- 1) don’t expose them to harsh chemicals like bleach or pesticides;
  - 2) try to keep the pH between 7 and 8; and
  - 3) maintain the temperature between 60° and 90°.
  - 4) Depending on the hardness of your water, the pH may have a tendency to go down. A pH corrector that uses potassium hydroxide can be added a little at a time to correct this. CropKing also has available food grade potassium carbonate, which has the added benefit of adding alkalinity to the system as well.
  - 5) If you have a window on your Tank, keep it clean with soft cloth but you needn’t worry about scrubbing the rest of the inside of the Tank. The walls harbor a lot of hard working microbes and scrubbing will remove them.
  - 6) Keep your system topped off with water so the bacteria living on the Lecastone media can do their job. Remember that if the beneficial bacteria are exposed to the air and allowed to dry they’ll die, and with them, the system’s ability to handle waste nitrogen.

Take care of your beneficial bacteria and they’ll take care of you by helping you to grow terrific crops the year round.

2. **Air:** Oxygen from the air is consumed at each point in the Aquaponic System. Air is added to the Aquaponic Tray for the plant roots and bacteria, to the Tank for the fish to breathe and at the bottom of the Airlift to return the water from the Tray to the Tank. Each of these air lines has it's own valve. You will develop a feel for the best adjustment of the valves, but to start off with:

- a) turn each valve completely open, then
- b) adjust the Tray valve by closing it off about 1/16th of a turn. Putting your ear close to the Lecastone bed, you should be able to hear the air in the bed bubbling away. If not, open the valve a hair more, making sure that the water is still moving back into the tank. Taking the "S" off the end of the Return Pipe helps with this observation.



### Valve positions on airlines

- c) With a little practice and observation you may end up adjusting the Tray or airlift valves away from these initial settings. One of the valves, preferably the one leading to the fish tank, should always be fully open in order to get the most out of your air pump. Oxygen at the outflow end of the Tray should be at least 2-3 ppm to ensure adequate aeration of the beneficial bacteria.
3. **Circulation:** Water in the fish Tank is driven in a circular motion to take advantage of the tank's round shape. The water spinning in the tank moves the settled solids in towards the center, where the dirt is then removed down through the drain and away from the fish. The circular pattern is induced in two ways: 1) the Flow Hood is placed over the rising column of bubbles coming from the air stone or diffuser. The pitch of the Flow Hood drives the bubbles and the water they bring up with them in a single direction. 2) Water returning from the Tray via the Airlift can be directed down into the tank using the pair of PVC "elbows" on the end of the delivery pipe. The elbows insert into each other to form an "S" shape, and one end of the "S" inserts onto the end of the delivery pipe. To operate efficiently, the open end of the "S" should be submerged no more than half way into the tank's water (adjust by rotating the upper elbow) and it should be aimed along the wall, somewhat towards the center of the tank (adjust with the lower elbow). The actions of the Flow Hood and

returning water complement each other and help to provide for maximum efficiency in inducing the circular flow pattern.

## II. Ready, Set, Grow!

1. **Water Source:** Water used in your Aquaponic System can be from the tap (from a municipal source), from a well or spring or rain or even reverse osmosis. Each one has advantages.
  - a) Well and spring water may be best because they can contain natural sources of trace elements like calcium, chloride, sodium and iron. Circulate and aerate the water in the system for at least a day before adding fish or bacteria to make sure that oxygen is adequate and any commonly found gases that are harmful to your system, e.g., hydrogen sulfide and carbon dioxide, are released.
  - b) Municipal water can have chlorine in it, which is not only harmful to the fish but can also kill off your biofilter. If you know or even suspect chlorine in your water, it must be removed prior to adding bacteria and/or fish. This can be done chemically with Tap Water Conditioner, available from CropKing, which removes other potentially harmful components as well. Chlorine can also be removed with plenty of aeration: just let the system run for a couple of days or more to get all the chlorine out. Using a chlorine test kit can help you to find when the water is ready, when there is less than 1 part per million (ppm) of chlorine. Municipal water sources may also contain chloramine, which is also harmful to your fish and bacteria. Chloramine can be removed using the Tap Water Conditioner.
  - c) Reverse osmosis water is recommended last due to it's lack of anything beneficial to your plants, but at least it shouldn't have anything harmful, either. You'll just need to be more careful about ensuring the availability all the essential elements when using r.o. water.
1. **Aquaponic System start up:** Your plant crops will exist because there are animals (the fish) that provide their nutrients. But before you can plant your seedlings, there must be adequate nutrients in the water.
  - a) **“Head start” method.** To provide you with a “head start,” your Aquaponic System comes with hydroponic nutrients so you can start planting right away, even before you add fish! As the plants deplete the bottled nutrients, the fish are being fed and will grow to replace those nutrients with their own metabolic byproducts. It generally takes from 3-4 days to a couple of weeks for your system to get completely adjusted or “seasoned,” depending on your particular circumstances. Your patience will be rewarded with a healthy, active growing system ready to start producing fish and plants crops through out the year.

- 1) Add your bottle of beneficial bacteria at the same time that you add the bottled nutrients.
  - 2) Plant seedlings any time 1-14 days after adding bacteria and nutrients.
  - 3) Add your fish within 2 days after the bacteria.
- b) Pre-conditioning-the-filter method of start up.** If you choose, you can spike your system with household ammonia and let your system build up nitrate naturally prior to adding fish and planting in the aquaponic bed. Traditionally, this is the way most systems are started.
- 1) Add 2 tablespoons of household ammonia (no scent, no detergent, no suds, no color-- just straight, clear household ammonia) and add the bacteria. The bottles of hydroponic nutrients may also be added at this time, if you wish.
  - 2) The Tank is ready to stock with fish when the **nitrite** level has peaked and fallen back down to about 1 part per million (ppm) or less. Ammonia level should be fairly low as well, less than 1 ppm. This means your bacteria have done their job and need more fuel, this time from the fish. Depending on the water source, temperature and other factors, this can take anywhere from one to four weeks.
  - 3) Planting of seedlings can begin about a week after the fish are added, since nutrients will then be present in adequate quantities.
- c) The fish-alone method of starting up.** The completely natural way to start up a system will take longer to build up the nutrients, and therefore longer before you can put in the plants.
- 1) Introduce the fish and bacteria into the tank.
  - 2) For juvenile or adult fish, feed them on a limited basis for 2-4 weeks, carefully monitoring ammonia and nitrite levels. Spot-check the nitrate as well to anticipate the earliest planting time. If small fry are added, they'll need less food overall, but again, watch the nitrogen levels carefully to ensure the fishes' tolerance is not exceeded.
  - 3) After the first month, nitrate level should be over 10 ppm. Try a limited planting, say ¼ of the Aquaponic Tray. After one week, if the plants do not show signs of lack of nutrients, plant another ¼ of the Tray. Continue in this manner until the tray is fully planted.

- 4) It generally takes at least a couple of months to build the nutrient levels up to the point where the Tray can be fully planted. For some, the advantages of a certifiably “organic” plant crop make it well worth the wait.

## 2. What to put into your Aquaponic System

- a) **Fish:** The Aquaponic System has been successfully used for growing food fish, ornamentals and bait fish.
  - 1) A table is appended to the end of this Manual to give you an idea of the water quality tolerances of various fish species. When planning this part, pay closest attention to the temperature needs of the fish and make sure the Aquaponic System will be operated within the necessary range. For the plants' sake, it will be good to aim for stocking enough in the tank to eventually reach a minimum of 25 lbs of fish.
  - 2) We recommend starting off with a hardy and robust fish such as tilapia. The many kinds of tilapia are generally quite tolerant of a wide range of environmental conditions and they taste great too! Our Aquaculture Department can recommend many reputable sources of tilapia fry—just give us a call. If you want to operate with warmer water, Nile (*Oreochromis niloticus*) and Mozambique (*O. mossambicus*) would be good choices and will grow fastest in their optimum temperature range of about 85°F; Blue tilapia (*O. aurea*) will fare better in cooler waters down to 60-70°F on a daily basis.
  - 3) Stocking mortality can be reduced by making the fish's introduction to their new environment as gentle as possible. If they arrive in a plastic bag (usually inflated with oxygen), float the bag in the tank for 15 to 20 minutes to get the temperature inside the bag evened out with the tank. Open the bag and scoop some water from the tank into the bag. Wait a few minutes and introduce some more tank water. After a few more minutes, the fish will probably be anxious to get out: tip the bag and let the fish swim out into their new home. Wait at least a few hours before trying to feed them—many fish are anaesthetized for shipment and won't have much of an appetite right away. When they are ready, try to feed at the same times each day, and only give what they'll readily eat in a 15-minute period.
  - 4) We recommend having a broad range of sizes of fish in your Tank so that when you harvest only the largest, your plants won't lose their source of nutrition. A healthy system can have 80 pounds or more of fish in it that you can continually harvest. Mortality is a natural part of life—animals can die for sometimes no apparent reason at all at any stage of the life cycle. When this happens, remove the body so that it won't decompose and become a source of disease, poor water quality and/or raise the ammonia level too high. (If the ammonia suddenly spikes, say over a one or two-day period, look for a body!) Don't worry if mortality

seems high, particularly right after stocking —commercial growers often expect 20% or more of the fingerlings they stock to die before harvest.

5) **Feeding:** Fish that are being fed on a daily basis, at least 2-3 times a day, will grow well for you. Feed no more than what they can consume in a 15-minute period. Floating feeds are best for recirculating systems because they allow you to observe how much is being consumed and none is lost through the drain right away. Try not to increase the amount being fed by more than 10% on a daily basis so as not to overload the filtration capacity of the system. Tilapia are typically given feeds with protein that ranges from 25% to 35%. Perch and other carnivorous fish need a diet with higher protein levels. Pellet size should be matched to mouth size, since a small fish can't take in large nuggets of feed. Starting 1-2" fry on a #2 or #3 crumble is common. A bag of larger size feed can be purchased and the pellets crushed for the small fish in a blender, with a mortar and pestle or even between two bricks, although the very fine powder should be sifted out prior to giving it to the fish. As the fish grow, pellet size is increased and protein levels can come down somewhat. Many commercial fish feeds have a shelf life of three- or four months. Ask the vendor how long it can be kept. Storage should be done in an opaque, airtight container and put in a cool place away from insects and rodents. Freezing is OK too.

6) An outstanding reference for anyone wanting to learn more about fish farming is "Fundamentals of Aquaculture," by Dr. James Avault. It is available from CropKing.

b) **Plants:** An amazing variety of plant crops can be grown with your Aquaponic System, including salad greens, herbs, flowers and fruiting vines. Be sure to explore to its fullest potential!

1. We recommend starting with leafy greens like lettuces and herbs. Bibb, romaine and leaf lettuces do particularly well, as does watercress, basil, chives, mint and many other herbs.
2. Planting on a staggered basis will provide continuous harvesting and ensure that there will always be plants in the system to take up the nutrients generated by the fish. For example, if your crop takes four weeks to grow and you divide your Tray in fourths, you'd germinate some seeds each week. Have fun experimenting with different planting patterns, different crops and mixing the plants that you put in!
3. To maximize the use of your growing space, keep your seedlings in their sprouting tray as long as possible before introducing them to the Aquaponic Tray. For example, it is common to leave lettuce seedlings in their sprouting tray for about 3 weeks, or until they grow four true leaves. Then transplant them to the Tray and let them grow there for another four weeks or so until harvest.

4. If you use an inert media to germinate the seeds, e.g., the rockwool cubes in CropKing's Seedling Starter Kit, it's important to water with a half strength fertilizer solution ("Miracle-Gro," etc.) one to two times a week after they sprout and until the seedling is placed into the Aquaponic Tray. This will ensure adequate nutrition. Make sure the media never dries out either.
5. When you plant the seedlings, make sure that most of the seedling starter cube (or other germination media) is pushed down into the Aquaponic Tray growing media. Plants that wilt or dry out may not be getting adequate access to the aquaponic water: ensure that the seedlings' cubes remain damp after transplanting by checking them and pushing farther down into the media, if necessary.
6. Replace plants as they are harvested or as necessary to keep the bounty of your Aquaponic System flowing.
7. Be sure that tall or vining plants will have adequate support for stems and fruit.
8. Nutrients other than nitrogen: You may recognize nitrate as a key component in commercial plant fertilizers. The plants use the nitrogen produced by the fish for growth—it's especially good for green foliage. Higher protein content in the fish feed usually relates to higher nitrogen content in the water. Depending on the fish feed, the plants will also have other nutrients available for growing, including some potassium, phosphorous and trace elements. If you note unusual growth patterns in the plant stems, leaves or fruit, there may be a nutrient deficiency. For example, lettuce often needs a little more iron than what comes in many fish feeds. Pale yellow spotting ("chlorosis") in lettuce leaves can occur when iron is too low. In this case, the addition of a little chelated iron may be called for. "*Hydroponic Food Production*," by Dr. Howard Resh, is an outstanding resource for diagnosing nutrient deficiencies, among other things. (This reference is available from CropKing.) There is also plant tissue and water analysis available; CropKing routinely facilitates this service for our commercial hydroponic growers and we would be happy to assist you with this should you decide a lab analysis would be helpful to you. We also carry a full line of micronutrients, such as chelated iron, at very reasonable prices to help ensure the success of your efforts.
9. If plants show signs of slowed growth, lighter than normal leaf color, and the nutrient levels are fine, it may be that adequate light is lacking. Installing full spectrum fluorescent lamps or metal halide sun lamps can correct this; these items are available from CropKing.

**3) Monitoring water quality:** The importance of monitoring water quality in the system can not be over emphasized.

- a) While you can get all of the meters and test kits from CropKing that will help you to monitor water quality, the most basic, important things to watch are pH, ammonia, nitrite and temperature. It's good to know what the alkalinity and hardness of the water is, so that you have a feel for its buffering capacity (resistance to major swings in pH) is, and occasionally the oxygen and carbon dioxide levels, too. Test kits can also tell you whether you're running low on calcium (an essential element in transporting nutrients across cell membranes), iron (part of photosynthesis-- helps keep things green), potassium (important for fruit development) and phosphorous (essential in flowering). Observing the plants can, with practice, also tell you much the same news on any deficiencies. Again, "Hydroponic Food Production" by Dr. Howard Resh is a great reference to guide you along in this learning process.
- b) Ammonia is actually present in two forms: the ionized "harmless" form  $\text{NH}_4^+$ , and the un-ionized or toxic form,  $\text{NH}_3$ . The amount of toxic un-ionized ammonia depends on the total ammonia ("Total Ammonia Nitrogen" or TAN), the pH and the temperature of the water. The table in the accompanying publication "Ammonia in Fish Ponds" gives the exact proportions of toxic to non-toxic forms, making it easy to calculate just how much you have in your system.
- c) Different species of fish have different tolerances to ammonia and nitrite, e.g., tilapia and catfish tend to be quite tolerant while trout and other salmonids are less so. Refer to the table in the Appendix for guidelines on operational tolerance levels ("operational" because these are what the fish are considered to need on a daily basis while still maintaining good growth; many fish can handle temporary spikes higher than what is given.)
- d) Ammonia, nitrite, pH and temperature should be measured frequently enough to give you a feel for the status of your water quality. Testing on a daily (or at most weekly) basis is an excellent way to monitor the status of your system and provides you with records that will help you to anticipate and understand potential problems before they arise. In particular, new systems that are being started up using the fish alone method should be tested for ammonia, pH and nitrite daily to assist in determining when planting can begin. Monitoring can be done with test kits or electronic meters; all are available from CropKing for your convenience. A Nitrate Test Kit can complete the nitrogen cycle picture for you and may be worth getting as well.
- e) pH in recirculating systems normally goes down over time due to the introduction of carbon dioxide and the generation of metabolic wastes. Increasing the buffering capacity of the system and bringing the pH back up to the "ideal" 7.0-8.0 range is normally done with the addition of baking soda. The amount you add will depend greatly on the water source you started with, so try adding a little at a time. No more than a ¼ cup every 12 hours will help to ensure adequate mixing before measuring the pH again.

- f) If the ecosystem gets seriously out of balance (most often caused by over feeding), the fish may start behaving unusually, e.g. not maintaining a “belly down” position while swimming, gulping air or “gasping” at the surface, not eating well, etc. First check the water quality, particularly the ammonia, nitrite and pH. Fish often stop eating well when the ammonia level gets too high-- don’t feed for at least a day or so and always remove all uneaten feed from the water. Signs of nitrite poisoning make the fish look like they are deprived of oxygen and can include “gasping” at the surface. Again, hold off on the feed until the nitrites come back down. Reducing the amount of feed given, monitoring the ammonia and/or nitrites carefully and adding more bacteria to the system to help deal with it as a long-term solution.
  
- g) Many of the usual “quick-fixes” for excessive ammonia or nitrite have very limited usefulness for integrated fish and plant systems because of the effect on the plants. (These would include water conditioners like zeolite (a natural clay product) and products like Amquel that remove ammonia, uniodized table salt to reduce nitrite toxicity and large water exchanges (no more than 20% on a daily basis to reduce shock on fish and beneficial bacteria). All of these will have a negative effect on the growth of the plants by either removing or locking out nutrients or impairing their ability to take up water.) It can take several days for the system to get back on track again—most fish can handle not being fed for this period. If the fish are showing signs of nitrogen stress, e.g., “gulping air” at the surface, lack of appetite, being overly skittish for no other apparent reason or not swimming well, *and* your tests for either ammonia or nitrite have shown that either was too high for least a couple of days, try exchanging no more than 20% of the water and temporarily cutting back on the feed. Then be patient, keep an eye on things, consider augmenting the bacteria population and most importantly, let nature take its course.

### 3) **Further Notes**

- a) **Power:** While extremely energy efficient, the Aquaponic system does require electricity to operate 24 hours a day. In a “worst case” scenario (with a tank fully stocked to capacity), the fish will run out of air to breathe in a very short time. (Time can vary with fish species and size, water temperature, altitude, indoor/outdoor, time of day and other factors. Generally speaking, in a fully loaded tank, it can be as little as less than half an hour or up to a couple of hours.) The plants will do fine for many hours without power since moisture is all they really need to stay alive during this period. If you run the tank at maximum capacity and are prone to power outages longer than 5 or 10 minutes, we highly recommend having the Air Pump plugged into an appropriately sized back up power source, such as a UPS (Uninterruptable Power Source, typically available from computer and office supply stores), having a generator available or having a DC powered air pump on hand for aerating the fish tank only. Should the fish crop be lost in such a

circumstance, you can keep your ecosystem going by adding a little household ammonia to replace what the fish were contributing. It is important to keep the beneficial bacteria alive with a source of nutrients so that when new fish are re-introduced, the System is still ready.

- b) Again, as noted above, water tests should be done frequently enough to make sure you know what's going on in the tank. A sample data sheet is included in the Appendix of this manual. Good note taking can be worth a great deal when trying to determine cause and effect.
- c) The screen on the bottom of the fish Tank may need rinsing if it gets clogged with debris. Before unscrewing the screen, have a pipe available to insert into the drain hole to prevent the fish from swimming down into it. Also shut off the cutoff valve to reduce the chance of any small fish being sucked down the drain.
- d) Check the bucket used to catch the overflow from the protein skimmer regularly to see if it needs emptying. Depending on the properties of the water being used, some people experience more discharge or "supernatant" from the skimmer. In particular, it can be more abundant for a period during system start up, and will then taper off. No need to worry if this happens with your System--just keep the tank topped off (an automatic float valve is nice for this) and it should settle down within a couple of weeks or so.
- e) Your Aquaponic System has been engineered to maximize ease of operation. To drain the tank, simply shut the air off to the airlift pump, shut the gate valve and hook up a garden hose to the faucet spigot. Open the spigot and let the tank drain down. To drain the Tray, let the Airlift pump the water into the Tank and again drain through a hose attached to the spigot.
- f) Your local Agriculture or Aquaculture extension agent can also be an excellent resource for assistance. Also feel free to call our friendly Aquaculture Department for information on growing requirements of particular species of fish or plants in integrated systems. We've had great success growing many types of lettuce, basil, chives, sage, mint, comfrey, and other herbs, watercress... Try melons or cucumbers if you have the space. Folks have used these systems to root tree cuttings, produce flowers, tomatoes... Part of the joy of the Aquaponic System is discovering the things you can grow with it!

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## TOLERANCE OF WATER QUALITY PARAMETERS OF CERTAIN FISH

	Dissolved	Un-ionized							
	Oxygen	Ammonia*	Nitrite	Temp.	pH	Hardness	CO2	Chlorides	Alkalinity
	(ppm)	(ppm)	(ppm)	o F	(units)	(ppm)	(ppm)	(ppm)	(ppm)
<b>Tilapia</b>	3.5-10	0-0.03	0-0.7	70-90	6.1-8.2	50-325	0-30	0-5000	50-250
<b>Catfish</b>	3-9	0-0.03	0-0.7	65-82	6.1-8.2	50-325	0-25	0-4000	50-250
<b>Bluegill</b>	4-9	0-0.03	0-0.6	60-85	6.1-8.2	50-325	0-25	0-2000	50-250
<b>Goldfish</b>	4-9	0-0.07	0-0.6	65-80	6.1-8.2	50-325	0-25	0-2000	50-250
<b>Shiners</b>	4-9	0-0.03	0-0.6	59-75	6.1-8.2	50-325	0-25	0-2500	50-250
<b>Yellow Perch</b>	4-10	0-0.03	0-0.5	50-70	6.1-8.2	50-325	0-25	0-2500	50-250
<b>Koi</b>	4-9	0-0.06	0-0.6	65-75	6.1-8.2	50-325	0-25	0-2000	50-250
<b>Carp</b>	4-9	0-0.03	0-0.6	65-80	6.1-8.2	50-325	0-25	0-4200	50-260
<b>Minnows</b>	4-9	0-0.03	0-0.6	57-75	6.1-8.2	50-325	0-25	0-2500	50-250
<b>Hybrid Striped Bass</b>	4-11	0-0.03	0-0.7	70-85	6.1-8.2	50-325	0-25	0-1400	50-250
<b>Walleye</b>	4-9	0-0.03	0-0.6	50-70	6.1-8.2	50-325	0-25	0-2500	50-250
<b>Trout</b>	5-11	0-0.02	0-0.2	45-70	6.1-8.1	50-325	0-20	0-1500	50-250

\*Un-ionized form; see chart to calculate what portion of your water sample's total ammonia is in this toxic form.

Range given is for long term care; many fish can tolerate short term spikes-- just back off on the feed until the toxic portion of the ammonia falls back down to the stated range.

\*\* These are general guidelines. By keeping your fish within the ranges shown above, they should stay relatively healthy and grow well. Variations can be found based on the genetics of your fish. We recommend discussing with the breeder or supplier of your fish any particular requirements.

## Southern Regional Aquaculture Center



January 1992

# Ammonia in Fish Ponds

Robert M. Durborow<sup>1</sup>, David M. Crosby and Martin W. Brunson<sup>2</sup>

Ammonia is the major end product in the breakdown of proteins in fish. Fish digest the protein in their feed and excrete ammonia through their gills and in their feces. The amount of ammonia excreted by fish varies with the amount of feed put into the pond or culture system – increasing as feeding rates increase. Ammonia also enters the pond from bacterial decomposition of organic matter such as uneaten feed or dead algae and aquatic plants.

## Forms and toxicity

Total ammonia nitrogen (TAN) is composed of toxic (un-ionized) ammonia ( $\text{NH}_3$ ) and nontoxic (ionized) ammonia ( $\text{NH}_4^+$ ). Only a fraction of the TAN exists as toxic (un-ionized) ammonia, and a balance exists between it and the non-toxic ionized ammonia:



The proportion of TAN in the toxic form increases as the temperature and pH of the water increase. For every pH increase of one unit, the amount of toxic un-ionized ammonia increases about 10 times. The amount of toxic un-ionized ammonia in your pond can be found by measuring the TAN with a water quality test kit and then looking up the fraction of TAN that is in the toxic form on

Table 1, which is based on water temperature and pH. Multiply this fraction by the TAN to find the concentration (mg/L or ppm) of toxic un-ionized ammonia present in the water. For example, if water pH is 8.6, water temperature is 30°C, and TAN is 3 mg/L (ppm), multiply 0.2422 (from Table 1) by 3 mg/L (ppm) to obtain 0.73 mg/L (ppm) toxic un-ionized ammonia.

Uptake (assimilation) of ammonia by plankton algae is important in reducing the amount of ammonia coming in contact with fish. Ammonia increases in the fall and winter because of reduced algae populations in the pond and algae populations which are not as capable of taking ammonia from the water. Additionally, lower water temperatures slow down aerobic bacterial activity, thus slowing the nitrification process whereby ammonia is converted to harmless nitrate (Figure 1). Algae die-offs can also lead to very high ammonia concentrations, but, fortunately, the low pH associated with the disappearance of the algae reduces the proportion of toxic un-ionized ammonia present.

Dangerous short-term levels of toxic un-ionized ammonia which are capable of killing fish over a few days start at about 0.6 mg/L (ppm). Chronic exposure to toxic un-ionized ammonia levels as low as 0.06 mg/L (ppm) can cause gill and kidney damage, reduction in growth, possible brain malfunctioning, and reduction in the oxygen-carrying capacity of the fish.

## Treatments

Treatment for high TAN concentrations is difficult in large pond culture systems. Pumping fresh water into the pond is not a practical or economical means of reducing the ammonia level for the whole pond. It does, however, provide a small area near the inflowing water where fish can go to find some relief. Maintaining high dis-

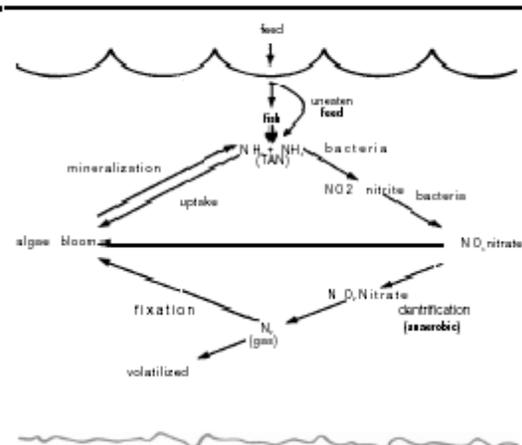


Figure 1. Nitrogen cycle in a fish pond.

<sup>1</sup>Cooperative Extension Program, Kentucky State University  
<sup>2</sup>Mississippi Cooperative Extension Service

solved oxygen levels by aeration will slightly reduce the toxic effect of un-ionized ammonia. In addition, TAN levels may be reduced through increased aerobic bacterial activity due to higher oxygen levels. Temporary reduction of feeding rates is recommended until TAN levels decrease to an acceptable level.

Prevention of high TAN is a better approach to the problem. The use of lower feeding rates and good feeding practices play a big role in keeping TAN levels low. Problems

with high TAN concentrations can be expected when feeding rates exceed 100 pounds per acre per day, or when excessive feed waste is occurring. Fish should not be overfed, and the feeder should be sure that fish are consuming feed offered. This is both of practical and economic importance, since feed costs are a major portion of production costs.

With pond and tank stocking densities continually increasing it is not often considered economically practical to reduce feeding rates.

However, the organic loading in these systems is a major factor that must be dealt with. Intensive recirculating systems may be better suited to handle these excessive amounts of nitrogen, but most pond systems probably have a finite limit to the amount of nitrogen and organic loading that can be managed. Unless more efficient management methods are developed, nitrogen and organic loading may become a limiting factor in stocking and production rates in culture ponds.

**Table 1.** Fraction of toxic (un-ionized) ammonia in aqueous solutions at different pH values and temperatures. Calculated from data in Emerson, et al. (1975). To determine the amount of un-ionized ammonia present, get the fraction of ammonia that is in the un-ionized form for a specific pH and temperature from the table. Multiply this fraction by the total ammonia nitrogen present in a sample to get the concentration in ppm (mg/L) of toxic (un-ionized) ammonia.

pH	Temperatures (°C)												
	6	8	10	12	14	16	18	20	22	24	26	28	30
7.0	.0013	.0016	.0018	.0022	.0025	.0029	.0034	.0039	.0046	.0052	.0060	.0069	.0080
7.2	.0021	.0025	.0029	.0034	.0040	.0046	.0054	.0062	.0072	.0083	.0096	.0110	.0126
7.4	.0034	.0040	.0046	.0054	.0063	.0073	.0085	.0098	.0114	.0131	.0150	.0173	.0198
7.6	.0053	.0063	.0073	.0086	.0100	.0116	.0134	.0155	.0179	.0206	.0236	.0271	.0310
7.8	.0084	.0099	.0116	.0135	.0157	.0182	.0211	.0244	.0281	.0322	.0370	.0423	.0482
8.0	.0133	.0156	.0182	.0212	.0247	.0286	.0330	.0381	.0438	.0502	.0574	.0654	.0743
8.2	.0210	.0245	.0286	.0332	.0385	.0445	.0514	.0590	.0676	.0772	.0880	.0998	.1129
8.4	.0328	.0383	.0445	.0517	.0597	.0688	.0790	.0904	.1031	.1171	.1326	.1495	.1678
8.6	.0510	.0593	.0688	.0795	.0914	.1048	.1197	.1361	.1541	.1737	.1950	.2178	.2422
8.8	.0785	.0909	.1048	.1204	.1376	.1566	.1773	.1998	.2241	.2500	.2774	.3062	.3362
9.0	.1190	.1368	.1565	.1782	.2018	.2273	.2546	.2836	.3140	.3456	.3783	.4116	.4453
9.2	.1763	.2008	.2273	.2558	.2861	.3180	.3512	.3855	.4204	.4557	.4909	.5258	.5599
9.4	.2533	.2847	.3180	.3526	.3884	.4249	.4618	.4985	.5348	.5702	.6045	.6373	.6685
9.6	.3496	.3868	.4249	.4633	.5016	.5394	.5762	.6117	.6456	.6777	.7078	.7358	.7617
9.8	.4600	.5000	.5394	.5778	.6147	.6499	.6831	.7140	.7428	.7692	.7933	.8153	.8351
10.0	.5745	.6131	.6498	.6844	.7166	.7463	.7735	.7983	.8207	.8408	.8588	.8749	.8892
10.2	.6815	.7152	.7463	.7746	.8003	.8234	.8441	.8625	.8788	.8933	.9060	.9173	.9271

Source: Emerson, K., R.C. Russo, R.E. Lund, and R.V. Thurston. 1975. *Aqueous ammonia equilibrium calculations: effect of pH and temperature*. Journal of the Fisheries Research Board of Canada. 32:2379-2383.

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# AQUAPONIC SYSTEM ACCESSORIES

## ***Stand for the Aquaponic Tray***

The specially designed Stand for the Aquaponic Tray is easy and convenient to assemble. Made from 1.315" GatorShield galvanized structural steel, the Stand is also strong and durable.

## ***Window***

The Viewing Window enables you to see just what your fish are doing at all times. Perfect for making observations on feeding behavior or just to watch your fish grow, this is one option you won't want to miss out on.

## ***Float Valve***

The Float Valve connects with a standard garden hose fitting to automatically maintain your Aquaponic System's water at its ideal level.

## ***Seed starter Kit***

Includes a tray, slab of rockwool seed starting cubes and a humidity dome to keep moisture in during germination. Convenient, easy to use and another proven winner in the Aquaponic System.

## ***Aquaponics Water Test Kit***

The importance of knowing the quality of your water can not be understated. This Test Kit comes with easy to use, step-by-step instructions for Total Ammonia Nitrogen, Nitrite Nitrogen, pH, Alkalinity, Carbon Dioxide, Dissolved Oxygen and Hardness. Also comes with an armored thermometer. (Additional test kits are available for Potassium, Iron, Phosphate and others-- please inquire.) Aquaponics Test Kit

## ***Heater***

Many fish need to be warmer than standard room temperature to optimize their growth. This stainless steel heater is a thoroughly reliable, industrial quality unit with temperature controls built on. If you need a water heater to keep your fish warm, this is **the** heater

you want to be relying on. Comes with clip-on bracket to hang on the side of the Aquaponic System Tank.

### ***Artificial Lighting***

Lack of light, particularly during the shorter winter days, can affect your indoor plant crops. These lamps offer full spectrum light to ensure your crops are healthy, green and growing like they should. Please see our Commercial and Hobby catalogs for prices.

### ***Tap Water conditioner***

The Conditioner eliminates chlorine and chloramine, both of which are toxic to your fish and beneficial bacteria. Either chlorine or chloramine will be found in water coming from municipal sources. Aeration alone can not remove chloramines. If you're using water from a public source, get Tap Water Conditioner to keep your critters and System safe.

### ***Digital Thermometer***

The large digit thermometer has a probe that stays inside the tank to monitor water temperature. Monitor water temperature with just a glance.

### ***Beneficial Bacteria***

This product is specially formulated to treat re-circulated aquaculture water.  
Use 1 teaspoon of product for 100 gallons of water. Add product once a month  
Or as needed as water changes. Be sure to check the filters regularly. Keep testing the pH  
As the microbial tends to lower the reading. Use baking soda to slowly increase pH

# Sources of Tilapia Fry

Among many others, you can get hybrid tilapia from these sources:

These folks appear to have excellent facilities, including regular lab inspections for tilapia pathogens, for fast growing Nile tilapia:

AmeriCulture  
HC 65 Box 260 C  
Animas, NM 88020  
Phone: 1-888-845-2742 or  
505:548-2328  
Fax: 505-548-2631  
email: [americulture@vtc.net](mailto:americulture@vtc.net)

Simaron Freshwater Fish, Inc.  
12946 Dairy Ashford Rd.  
Suite 150

Sugar Land, TX 77478  
281-242-3870 (T/F)

[rschmid2@aol.com](mailto:rschmid2@aol.com)

(Check to see if they have regular fish health inspections & can provide at least strep-free fish.)

Here's another good one for the fast-growing Nile tilapia, who also says they do routine health inspections. We've had lots of good feedback from customers acquiring fry from this source:

Living Waters Tilapia Farm  
171 John Smith Road  
Poplarville, MS 39470  
tel/fax: 601-795-8094  
email: [lwtf@datasync.com](mailto:lwtf@datasync.com)  
website [www.tilapia.net](http://www.tilapia.net)

If you want to stay current and active in aquaculture, I can highly recommend membership in the World Aquaculture Society.

The address is:

World Aquaculture Society  
143 J.M. Parker Coliseum  
Louisiana State University  
Baton Rouge, LA 70803

Internet:

<http://ag.ansc.purdue.edu/aquanic/was/was.htm>

and for "golden" and "red" tilapia:

Aquasafra  
P.O. Box 20608  
Bradenton, FL 34204-0608  
tel: 941-747-9161  
fax: 941-747-9476  
[picchietti@aol.com](mailto:picchietti@aol.com)

(They should have other colors available, too; they also promise strep-free fish)

Til-Tech Aquafarm  
45056 Riverdale Heights Rd.  
Robert, LA 70455  
504-345-3440 (T)

They seem to have very high quality stock, excellent health track record; "silver" and "pearl" colorations.

# CropKing's Beneficial Bacteria

This product is specially formulated to treat re-circulated aquaculture water.  
Use 1 teaspoon of product for 100 gallons of water. Add product once a month  
Or as needed as water changes. Be sure to check the filters regularly. Keep testing the pH  
As the microbial tends to lower the reading. Use baking soda to slowly increase pH