COMMERCIAL MICROBIAL SYSTEMS IN CALIFORNIA FOR TILAPIA.

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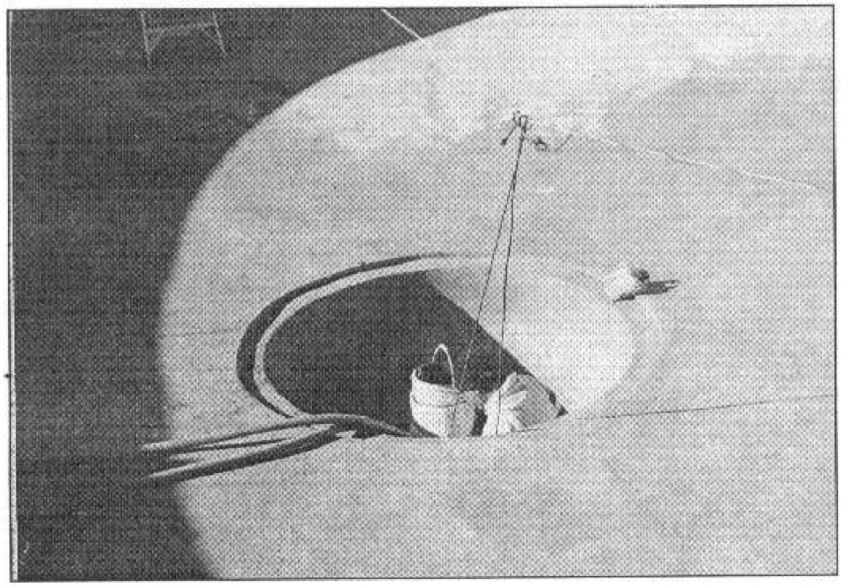
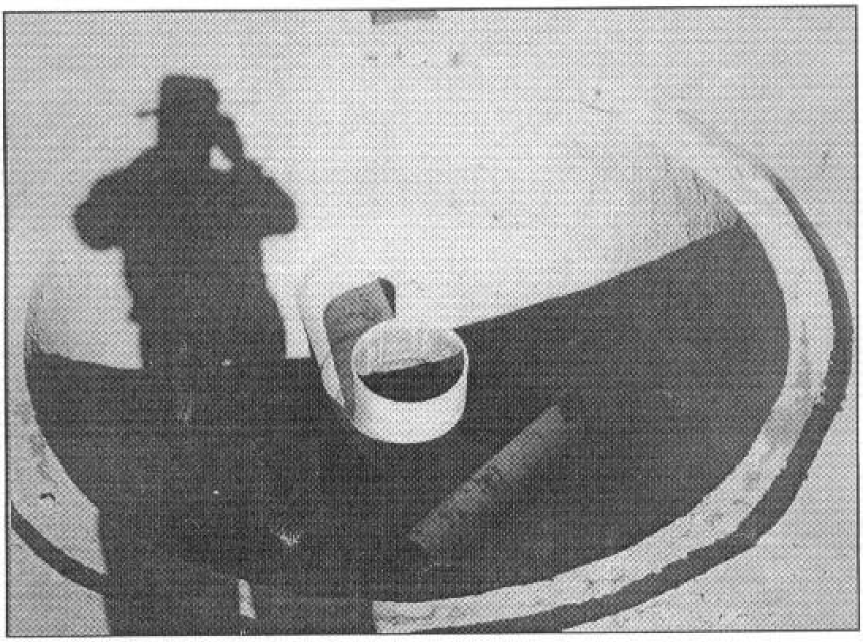
California has a 25 year history of using biofloc or active suspensión ponds and tanks. In 1982 Steve Serfling, (sunwatertech@earthlink.net), purpose engineered the first system for Solar Aqua Farms after some preliminary work in San Diego. This system was designed to operate with both bacterial floc and phytoplankton and grew in size to 1500 tons a year utilizing less than 1% new water daily. This was certainly the "Grand father" of all floc systems for Tilapia and probable for shrimp since they also raised shrimp early on. Since there have been many reports over the years on this system I will only report on two other types of farms. One intensive and one semi-intensive.

The intensive system was designed to take advantage of the bacterial floc which exists in the water column anyway, even if you do not want it there, in systems recirculating water to add oxygen. Since the floc, especially the autotrophic "pin floc", tends to settle slowly a settling devise was copied from Taiwán to attempt to settle the feces and allow most of the floc to recirculate and either convert or immobilize much of the total ammonia nitrogen.





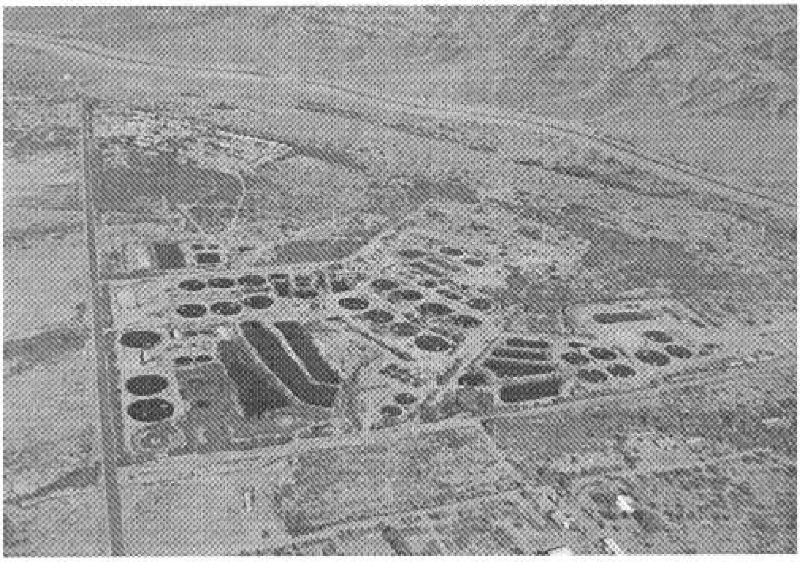
This center devise is designed to have the recirculation water move to the upper center pipe in a curved path which allows most of the feces to settle before reaching this point and it sinks to the bottom where it is withdrawn through the bottom pipe . The recirculation water from the upper pipe with most of the slow settling biofloc plus water off the side of the tank goes through a canal to a pump which lifts the water to a header tank where it is fed to an oxygen devise for each tank and flows by gravity back to the fish tanks. One pump serves the whole farm and is the only mechanical devise. There is no attached film biofilter or drum filter.

This farm runs high TAN in the 10 to 18 ppm range with impunity because the PH is controlled by allowing some CO2 to remain in the water. The alkalinity is 95 so if you leave (say) 30 ppm CO2 in the water the PH drops to below 7 and is usually about 6.5 so the NH3 component of the TAN is minimal. Several farms now use some form of this system and one uses acid.

The total water surface area is 1513 M3 or a little over 1/3 acre. 1 Kg is fed per M2 or the equivalent of 10,000 Kg of food per Ha. That is not a lot for a recirculation system with a fixed biofilter but is very high feeding rate for a system relying on microbes plus a 50% flushing rate per day. The stocking density is 68 Kg/M3. The end result is that about 52% of the TAN is being handled by the microbes through nitrification with some immobilization. There is not much phytoplankton envolved. The balance is flushed out with the high TAN content. More could be removed if a higher percentage of the autotrophs could be recycled.

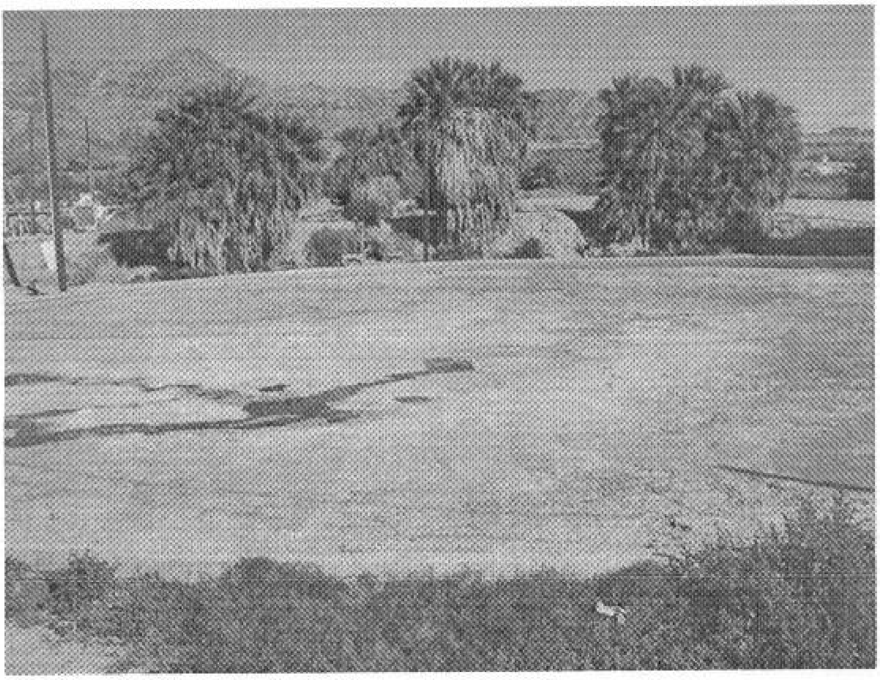
There are a couple of ways to increase the stocking density. One is to add carbon to immobilize the ammonia. Another has been studied by Oliver Schneider, et al, at the University of Wageningen in The Netherlands. This involves taking the feces outside the fish tank and adding a carbon source on a continuous basis. This is aerated and the microbial floc is returned to the fish tank. Not only does this immobilize the TAN in the heterotrophic cells but it increases the protein 50% over that provided by the food. This can be effectively utilized by the Tilapia. It also means that the bacteria flushed with the feces would be returned to the fish tank better utilizing the autotrophs.

The next farm is the largest outdoor Tilapia farm in the USA. Pacific Aqua Farms in Niland, California.

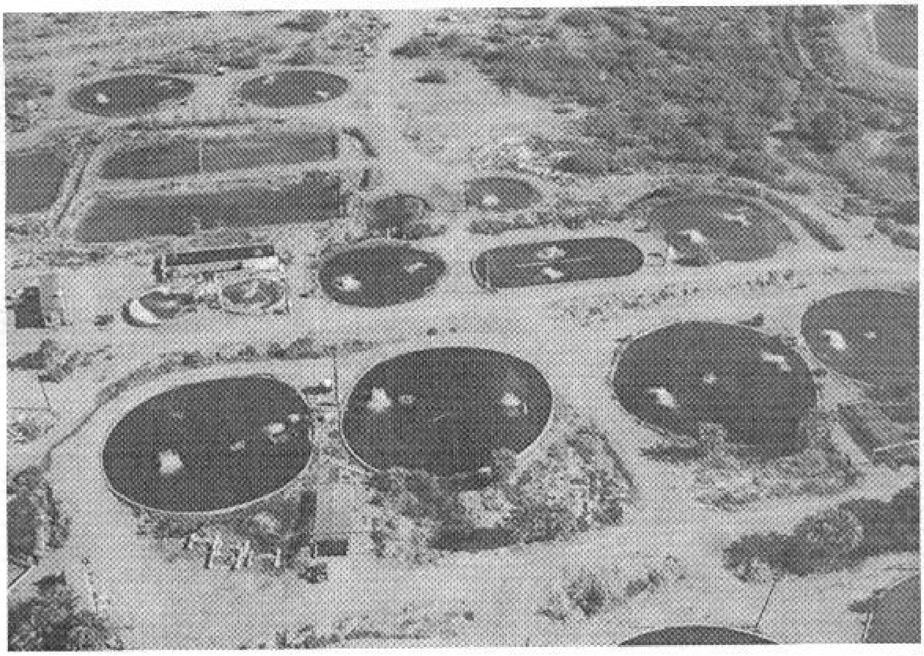


As you will see there are a variety of tanks and ponds. Most are operated with paddle wheels but there are 10 X 200 M3 tanks using liquid oxygen that produce the same amount as 10 of the large 1000 M3 ponds.
This is the farm where Yoram Avnimelech from Technion, The Israelí Institute of Technology studied the microbial uptake by the fish using 15N tagging and found that 40 % of the fish growth came from the biofloc. His work covers more than 15 years and has been reported in many papers but the work done here in 2004 was very significant not only in the information produced but it was real time at a real comercial fish farm.

The large 1000 M3 ponds are made of soil cement. This is simple cement and soil mixed together , compacted, and then filled with water to set. The row of cement blocks is just to add depth . Very inexpensive and long lasting.



The winters get cold so geothermal water has to be supplied to keep the temperature elevated. However in the summer they can run with less flushing . In some cases down to 5% . That means they can retain most of the biofloc and can convert most of the TAN in situ with bacteria and some phyto plankton. After Dr. Avnimelech´s findings in 2004 they decided to test two activated suspensión ponds against 8 regular ponds. The ASP ponds to get 22% protein feed because of the protein in the floc and the convencional ponds to relieve the normal 32% protein feed. The ASP ponds are those where less water is exchanged and where wheat flour may be used to immobilize TAN until the autotrophs build up. The convencional ponds use more new water to flush TAN. Acid is used to lower PH to control NH3 especially in the convencional ponds. Each pond has 10 to 12 HP of paddle wheels. Since they are 1000 M2 that Means 100 to 120 HP per Ha. Feed is about 220 Kg/pond. Stocking density is about 16 Kg/M3.



The results were very clear. The ASP ponds were superior to the conventional ponds in every measurement made. The conventional ponds ran about 12 ppm ammonia and the ASP about 1 to 3. Number of fish recovered was 4% higher . The FCR was lower. Less acid was used to lower NH3. The Kilos to Market were 15% higher. Most important of all from a comercial point of view was the cost per Kg . grown was $0.286 lower due to improved FCR and lower feed costs. It should be mentioned that possibly they were over feeding the ASP ponds because they fed the same amount of feed but the biofloc ponds the fish ate slowly and probable some of the feed was lost.

They also ran a test on a Burrows pond or D ended or center divider pond. This pond appeared to be better than than the ASP or conventional ponds, possibly due to better floc suspensión, but since it was a single tank and a different size I won´t report the numbers

After this test a decisión was made to try and improve production in the winter when more water has to be flushed. To do this they are going to try to recycle more of the autotrophs and also they will try using carbon to immobilize the TAN.If they use carbon it will be added outside the fish tank to improve the growth rate of the heterotrophs and to save oxygen costs.