Recirculation System Guidelines for High School Teachers

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Recirculation systems have two crops

1. bacteria
2. fish

A recirculation system must have the following:

1. culture unit
2. solids removal unit
3. nitrification unit
   -2 and 3 may be combined, as in a bead filter
4. temperature control
5. aeration
6. an emergency system/plan

System preparation

1. Fill system and drain after 1 week
2. Never clean with soap, clean water and a brush is the best.
3. Make sure alkalinity is 100 – 200 ppm
4. Chloride level at 200-2000ppm (0.275 –2.75 lbs/100 gal water)
5. Temperature set at 78 – 84 degrees F
6. Stock with either few adult fish or all small fish so the systems can grow together.
7. Measure all water quality parameters to determine your baseline
8. Check them every M, W, F after you stock the fish
   -Greater frequency gives more data points and better graphs

Water quality parameters:

1. alkalinity 100-200ppm (carbonates add alkalinity)
2. hardness 100ppm or more (calcium adds hardness)
3. chlorides 200-2000ppm (0.275 – 2.75lbs/100gallons)
4. temperature 78-84 F (25-29C)
   a. less T gives more DO or CO2 (liquid holds gas better)
   b. less T gives less ammonia (NH_3) in the TAN
   c. more T gives more biological growth
   d. T outside the fish's range causes stress
5. oxygen 5ppm or more (never less than 3ppm)
6. TAN: tilapia can tolerate less than 20ppm
   a. composed of two parts that can be calculated using a chart
   b. ionized ammonia NH_4^+ is non-toxic
   c. unionized ammonia NH_3 is toxic
   d. keep NH_3 levels less than 0.2ppm
   e. when the system is stable, TAN should be 3ppm or less

7. Nitrite less than 0.91ppm with no salt (chlorides) added
    a. if salt is used, max nitrite is 15ppm
    b. make sure there are 10ppm of chlorides for every 1ppm of nitrite
8. Nitrate less than 300ppm is not toxic
9. pH 7.0 – 7.2
    a. less than 7.0 hurts bacteria
    b. more than 7.2 hurts fish if TAN is high (up to 7.8 is fine if TAN is low)
    c. lower pH prevents NH and promotes NH_4^+
    d. respiration increases CO_2 which decreases pH

Management

1. Feed at least 5 days per week using satiation feeding
2. For every 1000g of feed (2.2lbs) given to the system, add 142g (0.3lb) of sodium bicarbonate (baking soda)
3. Test each day for T and DO
4. Test 3 days per week for TAN, nitrite, nitrate until they stabilize; one day per week thereafter
5. Test pH and alkalinity at least once per week
6. Keep records of all tests and feeding, stocking, harvesting, and mortalities
7. Use Tilapia Quick Fact Sheet
8. Grow tilapia for the first two years before using a different species
9. Feel free to call Bauer Duke for assistance
    a. 870 575-8143

AQUACULTURE

1. Pond

2. Recirculating systems
    A. Why?
        1. Low Water requirements
        2. Low land requirements
        3. Water temperature Control
        4. Water Quality Control
        5. Independence from Weather
        6. Proximity to markets
        7. Usefulness in Education
            a. Not so useful if everything dies
            b. If it lives,
                1. shows physics in action
                2. uses math
                3. demonstrates physiology and biology
                4. demonstrates chemistry

    B. Now extends to ponds

    C. System Design Objectives

1. Prevent disease
2. Waste Solids Control
   a. Settleable
   b. Suspended
   c. Floatable
   d. Dissolved
3. Nitrogen Control
   a. TAN (1 – 6ppm) **toxic**
      Nitrosomonas eat this
   b. Nitrite NO2- (0.5ppm) **toxic**
      Nitrobacter eat this
   c. Nitrate NO3 (100ppm) **non-toxic**

D. System Design Components

1. Fish Tanks
   a. crop one
2. Biofiltration
   a. crop two
   b. bacteria
   c. biofiltration media examples
      1. plastic beads
      2. gravel
      3. volcanic rock
      4. sand
      5. packing peanuts
      6. bio balls, koch rings
      7. plastic shavings from drums, pet bottles, milk bottles, etc.
      8. A/C pads
   d. usually treating a recirculation system for disease means killing the bacteria
3. Solids Removal Basin
4. Nitrification Basin
5. Temperature control
6. Aeration
   a. blower
   b. compressor
   c. water pump
   d. back-up oxygen
7. Feed delivery
   a. hand
   b. auto feeder
      1. timed
      2. belt feeder

10 Alarm System
11 Back up Emergency System
   a. Generator
      1. manual
      2. automatic
   b. Solenoid activated compressed oxygen

E. Start-Up
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4. Chloride level at 200-2000ppm (0.275 –2.75 lbs/100 gal water)
5. Temperature set at 78 – 84 degrees F
6. Stock with either few adult fish or all small fish so the systems can grow together.
7. Measure all water quality parameters to determine your baseline
8. Check them every M, W, F after stocking the fish
   -Greater frequency gives more data points and better graphs

F. Management
1. Water Quality Monitoring
   a. monitor 2,3,8 every day
   b. monitor 4, 5, 6, every MWF
   c. monitor 7 and 9 once per week.
2. Temperature
   a. 78 – 84 F (25 – 29 C)
   b. affects DO
   c. affects TAN
   d. affects biological growth rate
   e. affects stress level
   f. affects carbon dioxide level
3. Dissolved Oxygen
   a. use a meter if you can
   b. Winkler method is slow
   c. 5ppm is great
   d. don’t go below 3ppm
   e. your system works on bacteria, not algae like a pond, so DO with respect to feeding is more important than light or dark
   f. best buy right now is the 850048 DO meter from Pentairaes.com, about $450.00
   g. SPER Scientific Water quality meter about $350.00 + $35.00 with pH

h. Pinpoint II meter $260.00 (no temperature)

4. Ammonia (TAN)
   a. ionized ammonia, NH_4^+, little toxicity
   b. un-ionized ammonia, NH_3, high toxicity
   c. first parameter to spike
   d. can go to 20ppm
   e. when system is stable, should not exceed 3ppm
   f. as fish grow, more ammonia is produced. The bacteria should acclimate.
   g. Demonstration
      1. How do I measure TAN that is greater than 3ppm?

5. Nitrite
   a. nitrite should be less than 15ppm (with salt, 0.91ppm without)
   b. keep 6ppm of (15ppm nitrite = 90ppm chlorides)
   c. second parameter to spike

6. Nitrate
   a. not toxic to fish except at very high levels (>100ppm)
   b. third parameter to spike

7. Alkalinity
   a. tells you the buffering ability of your water
   b. the lower the alkalinity, the more likely your water will not hold a pH of 7 – 7.2

8. pH
   a. affects TAN
   b. best at around 7.0
   c. the bacteria like it closer to 7.5, but that causes problems with TAN
   d. fish like it closer to 6.9, but that causes problems with bacteria.
   e. affected by carbon dioxide and respiration
   f. Add 64g of bicarbonate for each pound of feed fed (142g bicarbonate/1000g feed)
   g. Demonstration
      1. 2 bottles
      2. airstones
      3. pH 4 indicator

4. baking soda in one bottle
5. one time keeper
6. 2 blowing teachers

h. Practical use of Ammonia chart from page 48

If pH = 7.0, T= 82 and TAN = 20
How much NH_3 is present
Is it stressful?

If pH = 7.6 T= 82 and TAN = 20
How much is NH_3 present?
Is it stressful?

If pH = 7.6 T = 82 TAN = 10
How much NH_3 is present?
Is it stressful?

If T = 82 TAN = 10
What is the highest pH you can have and not exceed 0.2ppm NH_3?

What can we do to detoxify the TAN of 10?

9. Carbon Dioxide
   a. increases with respiration
   b. increases with lack of agitation
   c. airstones help reduce carbon dioxide
   d. can make fish sleepy and not want to feed

10. Feeding
    Look at the Tilapia Quick Fact Sheet