Understanding Your Water Source For Use In Recycled Aquaculture Systems

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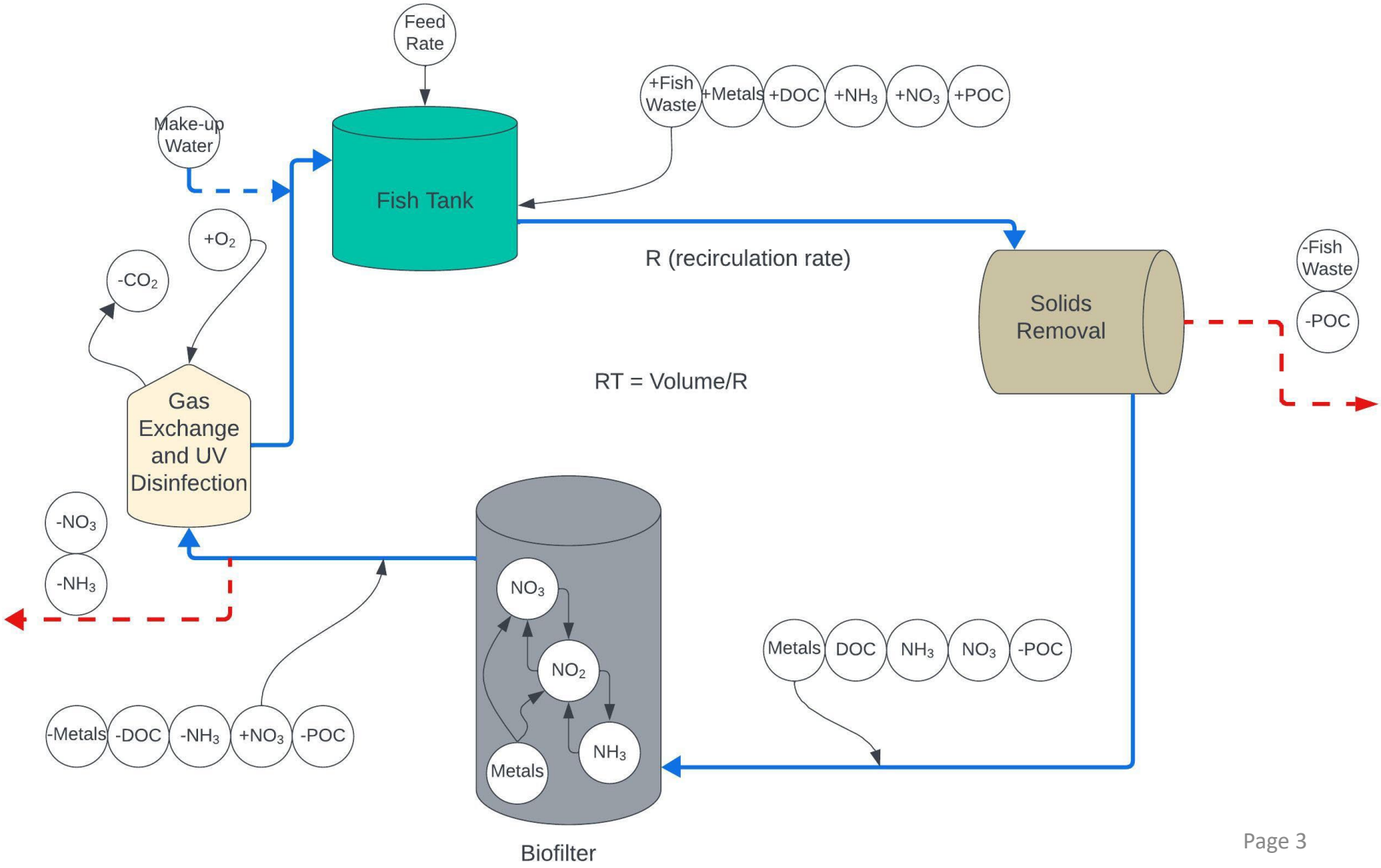
Water Source: Important Questions

- Is the source suitable for raising fish?
    1. Correct Quality or Correctable Quality: pH, temperature, clarity, mineral content, etc.
    2. Enough Quantity
    3. This is a fish biologist concern – specific to species
- Is the source suitable for RAS?
    1. Will water source support ammonia removal through controlled nitrification in a bioreactor?
    2. This question is rarely asked – nitrification is generally assumed to occur with a “hot-start”
    3. Source water quality can become a limiting issue for maximum yield

Basic RAS Diagram



Primary RAS Need: Nitrification

- Nitrification = 3 step biofilm process to convert ammonia (fish waste) to nitrate in a bioreactor
- Step 1: Conversion of Ammonium to Hydroxyl Amine (HA)
    1. Performed by Ammonia Oxidizing Bacteria (AOB)
    2. Requires oxygen and copper
    3. Requires acidity so that ammonia is ammonium
    4. Creates acidity so that HA is neutral charge
    5. HA is neutral charge at pH < 4 su
    6. AOB are negatively charged
    7. Biofilm needed to trap acidity to keep HA as an acid and make available to AOBs

Primary RAS Need: Nitrification

- Step 2: Conversion of HA to nitrous acid (HNO_2)
  1. Performed by Ammonia Oxidizing Bacteria (AOB)
  2. Requires alkalinity, phosphorus, iron and zinc
  3. Creates additional acidity
  4. HNO_2
     a. neutral at pH < 1.3 su
     b. 50% neutral at pH = 3.3 su
  5. Stable biofilm is needed to trap acidity to keep HNO_2 as an acid and make available to the next step performed by Nitrite Oxidizing Bacteria (NOB)
  6. This step is highly corrosive to metal and why plastics are used in RAS

Primary RAS Need: Nitrification

- Step 3: NO_2 to HNO_3
  1. Performed by Nitrite Oxidizing Bacteria (NOB)
  2. Requires alkalinity, phosphorus, iron, molybdenum and sulfur
  3. HNO_3
     a. neutral at pH < -3.3 su
     b. 99% anionic at pH = 0.3 su
  4. Biofilm will push this anion out of the biofilm via repulsion

Water Quality Requirements for RAS

- Source with low nitrate desired – self seeding
- Low to moderate pH and low ammonia.
    1. At pH<7.25, 99% of ammonia waste is present as ammonium (NH_4+)
    2. AOB are negatively charged and will attract NH4+
    3. Ammonia in source water may overload RAS treatment capacity
- Low dissolved organic carbon (DOC)
    1. DOC creates competition for ammonia
    2. DOC disrupts biofilm to cause release of acidity, HA and HNO_2 to disrupt nitrification
- Adequate metals and sulfur – prevent inhibition of nitrification process

Basic RAS Operation

- Hydraulics
  1. Volume of system, V (gallons or Liters)
  2. Recirculation rate of system, R (gal/min, L/min)
  3. Recycle Time, RT = V/R (minutes)
- Loading
  1. Feed Rate, FR (Kg/day)
  2. Ammonia produced per day, APR (grams/day)

     APR = FR * %waste
  3. Ammonia at steady state, AS (mg/L)

     AS = APR*1000/(R*60*24)
  4. Back calculate % waste from AS

Troubleshooting RAS

- Measure pH, ORP, conductivity, nitrite, nitrate and ammonia. Microscopy of media helpful.
- Nitrite curve followed by nitrate curve at startup
    1. Seeding – drip feed ammonia at a steady rate
    2. When the rate of ammonia increase slows down, nitrification is starting.
    3. As nitrite drops, nitrate should increase.
    4. May need to drip metals to assist seeding/startup.
- Climbing and then steady nitrate = desired
- Climbing ammonia and nitrite = undesired
    1. Caused by unsteady state, biofilm disruption, change is source quality, competition, or Inhibition
    2. MBBR may be too small for feed rate

Troubleshooting RAS

- Declining pH with steady ammonia and nitrite
  1. Sulfur oxidation
  2. Minor biofilm instability
- No ammonia or nitrite
  1. super stable biofilm
  2. Reduced feeding
- Poor water clarity
  1. HRT too long or feed rate to high – solids breakdown
  2. Slime production
  3. If amoeba present = recycle time too long
- Source water changes – biofilm in well
  1. Clarity
  2. Odor

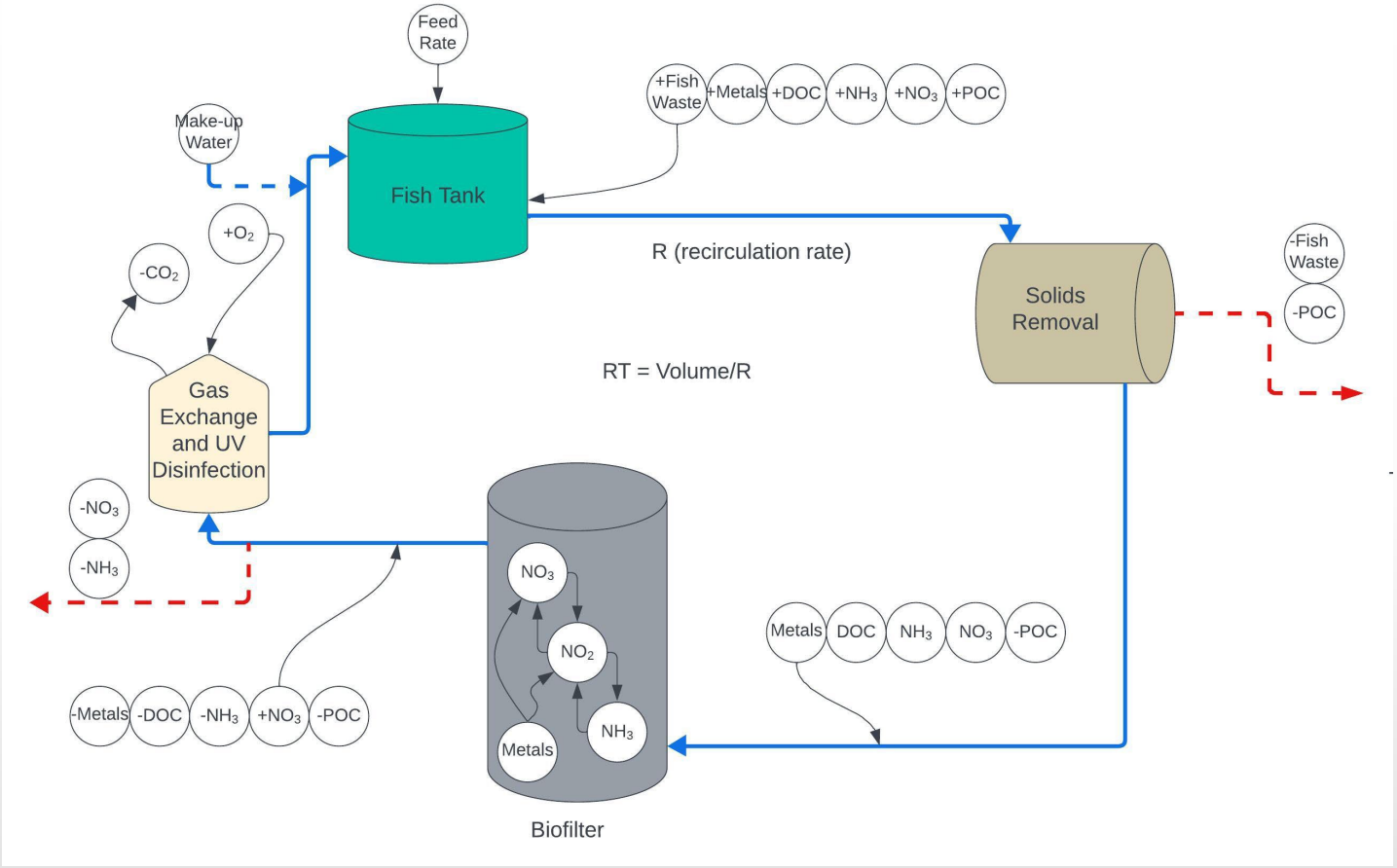
Simple Source Assessment

As Collected

After Bleach Addition

Well appears to have corrosive biofilm

Questions?



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