Water Quality Requirements/hygiene for Aquaculture

Parameters

- Temperature
- Dissolved Oxygen
- Alkalinity and Hardness
- pH
- Ammonia, Nitrite and Nitrate
- Miscellaneous

Water Quality

- Water Quality (WQ) determines the ultimate success or failure of an aquaculture operation
- The farmer must measure, record, and manage WQ all through the growing season
- Water Quality parameters affect respiration, feeding, metabolism, reproduction, and waste removal from environment

Temperature

- Affects the development and growth of fish more than any other single factor

  - Metabolic rates either increase or decrease with temp. change
  - Each species has optimal growth and reproduction temp. ranges.
    * Warm water species grow best above 21 C
    * Cold water species grow best below 21 C
    * Cool water species grow best at mid-range = 22 to 28
  - Fish are ectothermic animals, therefore same as surrounding water.
    * Sudden change causes stress and even death
  - Select species to culture according to the available water temp.

Dissolved Oxygen (DO)

- Temperature, salinity and elevation affect Dissolved Oxygen
- Salinity is the saltiness or dissolved salt content of a body of water

  - As these three factors increase, DO at saturation decreases.

    * Freshwater at sea level holds 9.2 ppm at 20C & 7.6 ppm at 30C

  - Fish become more active and increase their metabolism as temperature increases.

    * Need more DO as temperature rises to grow muscle tissue.

    * Minimum tolerable DO levels increase with a rise in temp.

With Rainbow trout, lethal level for DO is 1.6 ppm minimum at lower temperatures and 2.5 ppm DO at higher temperatures.

Table 1. Solubility of oxygen (ppm) in water at various water temperatures, salinities, and altitudes.

Variable	Water Temperature °F				
	68.0	**71.6**	**78.8**	**82.4**	**86.0**
Salinity (ppm)					
0	9.2	8.8	8.2	7.9	7.6
5,000	8.7	8.4	7.8	7.5	7.3
10,000	8.3	8.0	7.4	7.1	6.9
Altitude (ft)					
0 (Sea Level)	9.2	8.8	8.2	7.9	7.6
1,000	8.8	8.5	7.9	7.6	7.4
2,000	8.5	8.2	7.6	7.3	7.1

Dissolved Oxygen

- **DO Ranges for cultured fish**

  0 to 2 ppm - small fish may survive a short exposure, but lethal if exposure is prolonged. Lethal to larger fish.

  2 to 5 ppm – most fish survive, but growth is slower if prolonged; may be stressful; aeration devices are often used below 3ppm.

  5 ppm to saturation – the desirable range for all.

Dissolved Oxygen

- Biological Oxygen Demand (BOD)

- BOD is a measure of the oxygen used by all organisms in pond.

* Microbes (bacteria & fungi) use oxygen to decompose organics (may use 1-3ppm DO in 24 hours).

* Phytoplankton respire at night to use oxygen (may use 5-15ppm DO nightly).

* Fish respire day and night (may use 2-6ppm DO in 24 hours).

- DO falls at night, since all organisms are respiring; DO rises during the day, since plants photosynthesize to use carbon dioxide and eliminate oxygen (may gain 5-20ppm DO daily).

- Diffusion and wave/wind action add oxygen (may add 1-5ppm DO).

Alkalinity & Hardness

- Two similar parameters, but still different
- Alkalinity

- The ability of the water to accept hydrogen ions, neutralizes pH.
- Consists of negatively charged bases – carbonates, bicarbonates, and hydroxides.
- Expressed in equivalent concentrations of calcium carbonate.
- Carbonates and bicarbonates are sources of carbon for plants which is used in photosynthesis to make sugars.
- Alkalinity offers a buffering system to reduce pH swings.
- An intermediate range of 20 to 80 ppm is recommended.
- striped bass prefer above 80 ppm alkalinity.

Alkalinity & Hardness

- Hardness

  - Refers to the concentration of divalent cations (calcium, magnesium, and sodium).

  - Also expressed as the calcium carbonate equivalent concentration.

  - The same carbonate rocks responsible for most of the alkalinity are the main sources of calcium and magnesium cations for hardness.

  - Hardness may be an index of potential pond productivity.

    * Minimum of 20 ppm

    * Optimum around 100 ppm

pH

- The negative logarithm of hydrogen-ions concentration – a way to measure acidity

  - Scale used is from 0 to 14, where lower number reflects higher acidity and the higher number reflects higher alkalinity.
  - Water with 4.5 pH or lower has no measurable alkalinity.
  - Water with 8.3 pH or higher has no measurable acidity.
  - Value of 7 is neutral, when donors of hydrogen ions = acceptors
  - Recommended range for cultured fish is 6.5 to 9.0 pH
  - Acid death point is around 4, alkaline death point is about 11 pH.
  - Toxicity of ammonia to fish increases with an increase in pH.

Ammonia, Nitrite and Nitrate

- Ammonia

  - Ammonia gas from fish gills or decomposing organics dissolves in water. Some of it reacts with the water to produce ammonia ions. The remainder is present as un-ionized ammonia, which is acutely toxic to aquatic life.

  - The percentage of un-ionized in solution depends upon the pH and temperature of the water. As both go higher so does the toxicity.

  - Solubility decreases with rise in temp.

  - Test kits normally used measure Total Ammonia Nitrogen (TAN), therefore the fish culturist has to determine what % of total is toxic.

  - Recommended that un-ionized ammonia should be < 0.02 ppm to prevent stress and reduced growth.

  - Lethal to catfish at about 0.4 ppm.

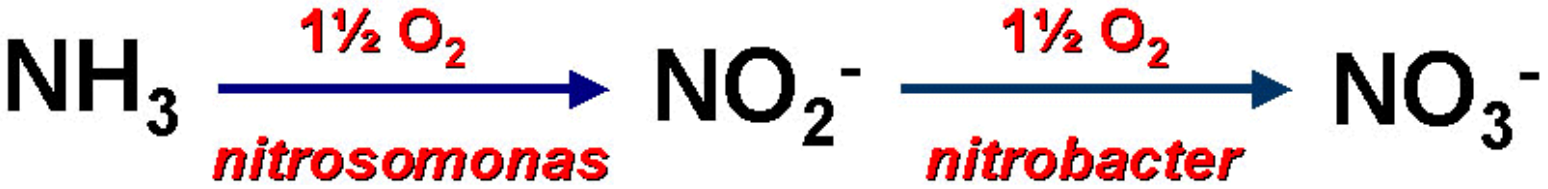
Ammonia, Nitrite, & Nitrate

- **Table lists the toxic percentage at different pH and temps.**

pH	Temperature (°C)								
	16	18	20	22	24	26	28	30	32
7.0	0.30	0.34	0.40	0.46	0.52	0.60	0.70	0.81	0.95
7.2	0.47	0.54	0.63	0.72	0.82	0.95	01.10	1.27	1.50
7.4	0.74	0.86	0.99	1.14	1.30	1.50	1.73	2.00	2.36
7.6	1.17	1.35	1.56	1.79	2.05	2.35	2.72	3.13	3.69
7.8	1.84	2.12	2.45	2.80	3.21	3.68	4.24	4.88	5.72
8.0	2.88	3.32	3.83	4.37	4.99	5.71	6.55	7.52	8.77
8.2	4.49	5.16	5.94	6.76	7.68	8.75	10.00	11.41	13.22
8.4	6.93	7.94	9.09	10.30	11.65	13.20	14.98	16.96	19.46
8.6	10.56	12.03	13.68	15.40	17.28	19.42	21.83	24.45	27.68
8.8	15.76	17.82	20.08	22.38	24.88	27.64	30.68	33.90	37.76
9.0	22.87	25.57	28.47	31.37	34.42	37.71	41.23	44.84	49.02
9.2	31.97	35.25	38.69	42.01	45.41	48.96	52.65	56.30	60.38
9.4	42.68	46.32	50.00	53.45	56.86	60.33	63.79	67.12	70.72
9.6	54.14	57.77	61.31	64.54	67.63	70.67	73.63	76.39	79.29
9.8	65.17	68.43	71.53	74.25	76.81	79.25	81.57	83.68	85.85
10.0	74.78	77.46	79.92	82.05	84.00	85.82	87.52	89.05	90.58
10.2	82.45	84.48	86.32	87.87	89.27	90.56	91.75	92.80	93.84

Ammonia, Nitrite and Nitrate

- Typical pond has bacteria, which in the presence of DO converts (oxidizes) ammonia to the intermediate form of nitrite and then to nitrate. Nitrite is more toxic to fish than ammonia, however, nitrate is relatively nontoxic.



Miscellaneous Water Quality Parameters

- Hydrogen Sulfide

  - A poisonous gas produced by anaerobic decomposition of organics.

  - If fish culturist smells “rotten egg” around the pond, aerate vigorously.

- Salinity and Chlorides

  - Salinity is a measure of the total concentration of dissolved solids, usually in parts per thousand (ppt). Anions (- charged) are chloride, sulfate, bicarbonate and bromide. Cations (+ charged) are sodium, magnesium, calcium, potassium, and strontium. Sodium and chloride are the major solids.

  - Freshwater = < 2 ppt; Brackish water = 2-16 ppt; Saltwater = 35 ppt.

Miscellaneous

- Carbon Dioxide

  - Consumed during photosynthesis by plants and expired during respiration by animals, plants (at night) and bacteria in the pond.

  - Levels > 20 ppm often harm the fish, especially if DO is low.

  - When added to the pond water by respiration or diffusion, it forms a weak carbonic acid, which lowers pH. DO and pH follow the same daily peaks.

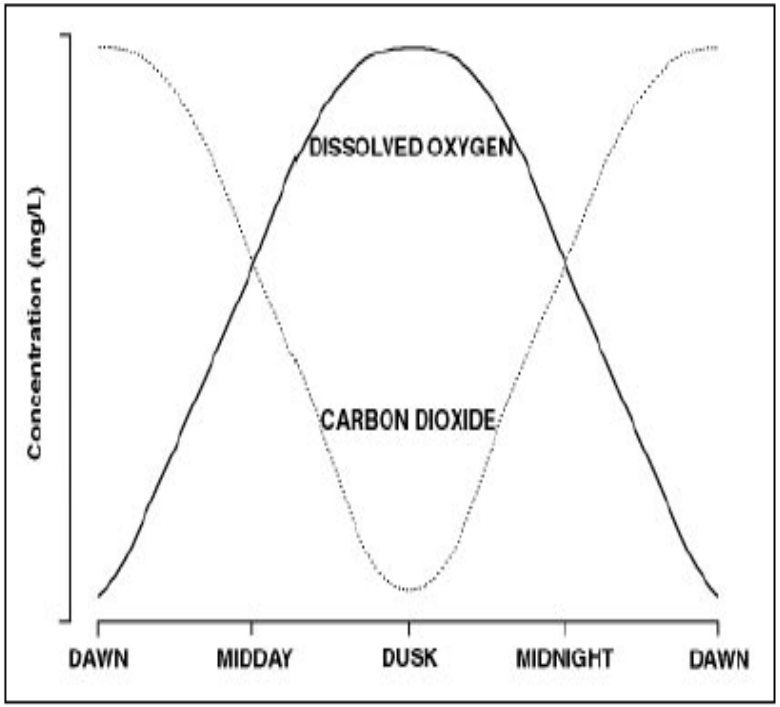


Figure 1. The daily cycle of oxygen and carbon dioxide in a fish pond.

Miscellaneous

- Chlorine

  - Harmful/Toxic to fish at > 0.03 ppm. City water may range from 4.0 to 8.0 ppm. Sodium thiosulfate can be used to neutralize the chlorine.

  - May be used to disinfect equipment, tanks and nets at 10 ppm for 24 hours or 200 ppm for 30 to 60 minutes.

  - Effectiveness is reduced by organic material such as mud, slime and plant material.

  - Sodium hypochlorite (HTH) is available at 15%, 50%, or 65% active. To make a 200 ppm solution:

    Add 2 oz. of 15% active HTH to 10.5 gal. of water,

    Add 1 oz. of 50% active HTH to 18 gal. of water, or

    Add 1 oz. of 65% active HTH to 23 gal. of water

Miscellaneous

- Toxic Materials

  - Some industrial and agricultural substances are toxic to fish, such as heavy metals, herbicides and pesticides.

  Examples of heavy metals are zinc, copper, cadmium, lead and mercury.

  - Minute amounts (5 parts per billion) of some toxic materials are sufficient to be toxic to aquatic life.

Hygiene of ponds/tanks

- De-odorase
- Removal of ammonia
- Extracted from plant *Yucca shidigera*
- Containing enzymes and glyco-comonents such as sapogenin, smilogenin,chlorogenin
- Glyco-components selectively bind ammonia
- Producing non toxic nitrogenous compounds which are used by bacteria

Hygiene of ponds/tanks

- Chlorine dioxide
- Disinfectant in gas and liquid form
- Low toxicity
- Bactericide, viricide, slimicide, protocide
- Less corrosive
- Effective over broad range of pH (5-10)
- 150 – 250 ml per acre feet every 15 days

Hygiene of ponds/tanks

- Aquazyn
- Blend of cultured bacteria, enzymes and buffers
- Degradation of organic wastes from dead phyto, zooplanktons, faeces and unconsumed feed
- Increases average biomass and survival
- decreases biochemical oxygen demand and pond bottom sludge

Hygiene of ponds/tanks

- Aquazyn
- Improves FCR
- Increases nutrient availability for plankton growth
- Non pathogenic, non toxic, biodegradable

Hygiene of ponds/tanks

- Sokrena
- Liquid pond sanitizer
- 1 mg/L or 10 L of chemical per hectare
- Effective against broad range of bacteria, fungi and viruses
- Most effective in alkaline environment
- Effective even in presence of organic matter
- Does not settle on pond bottom

Hygiene of ponds/tanks

- Geolite
- Natural aggregate of inorganic salts i.e. silicon, aluminium, calcium
- 10 kg/ hectare
- Improves growth and survival
- Water quality
- Neutralize pH of water and soil
- Decreases water turbidity
- Removes bad odor of water