WATER QUALITY MEASUREMENTS IMPORTANT IN CATFISH AND MINNOW PRODUCTION

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Alkalinity and Chlorides

Check 3 weeks after pond is filled and again if a large volume of water (well, rain, runoff, etc.) has been added to the pond. Alkalinity should be at least 40 ppm, better if above 70 ppm. Chlorides should be at least 30 ppm, better if above 50 ppm. For safe effective copper sulfate treatments the total alkalinity level must be determined. Alkalinity is also important for carbon dioxide determinations.

Dissolved Oxygen

Check early in the morning as needed. Oxygen levels should be maintained at 4 ppm and above. Low oxygen problems primarily occur in the summer between midnight and dawn.

Temperature

Check as needed--important in determining toxic levels of ammonia and carbon dioxide.

pH

Check once weekly whenever a water quality problem is suspected. Fish die at pH readings below 4.5 or above 11.0. Best range is pH 6 to pH 9.5. Important in determining toxic levels of ammonia and carbon dioxide.

pH less than 7.5

Carbon Dioxide

Check early morning. Above 35 ppm is a high pond reading. In tanks with golden shiners, the levels should not exceed 20 ppm. Toxic carbon dioxide problems that usually occur in the summer are often associated with low dissolved oxygen.

Nitrites - (for comments see Nitrites in Ph above 7.5)

catfish

Hydrogen Sulfide

Check if pH is less than 6.5. Any measurable amount is too much--usually associated with the seining of fish in older ponds.

pH above 7.5

Ammonia

Fish may die when unionized or toxic ammonia levels reach 0.05 ppm for a few weeks or when levels reach 0.4 ppm for a few days. The occurrence of high ammonia readings is correlated to crowded and heavily-fed ponds and the warmer months of the year.

Nitrites

This is important when raising catfish, and chlorides are less than 50 ppm. Check every 2 days if nitrite exceeds 0.05 ppm and chlorides are less than 50 ppm. Fish should be considered in stress if the ratio of chlorides to nitrites is less than 7:1. Brown blood disease caused by high nitrites usually occurs in the spring and fall. Bait minnows rarely if ever experience nitrite kills in ponds.

Miscellaneous Measurements

Iron

It is usually a problem in vats or small ponds receiving large quantities of well water. 0.1 ppm can harm fry. Fish are harmed if they are exposed to 0.5 ppm to 1 ppm for several days to a week. Fish may die if exposed to levels above 1 ppm for 2 to 3 days.

Hardness

It is of concern when hatching fish eggs. Calcium hardness levels should exceed 5 ppm. To get a good phytoplankton bloom, hardness levels of 20 ppm or greater are desirable.

CHLORIDES

WHY ARE THEY IMPORTANT?

1) Offer protection against nitrites
2) Winter kill of catfish is directly related to ponds with low chloride levels.
3) Pond with good chloride levels have fewer off-flavor problems.

WHAT LEVELS ARE DESIRABLE?

1) Less than 30 ppm -- Not desirable
2) 31 to 50 ppm - OK
3) 51 to 2,000 ppm - good
4) Above 2,000 may be toxic to some fish

HOW TO ADD CHLORIDE TO PONDS

For ever part per million needed add:

—4.5 lbs of sodium chloride/acre ft of water

4.3 lbs of calcium chloride (anhydrous)/acre ft of water

5.6 lbs of calcium chloride (dihydrous)/acre ft of water

FORMULA FOR CHLORIDE TREATMENT OF A NITRITE PROBLEM

$(7 \times N) - C$ = Amount of Chloride to add in ppm

N = Nitrites measured
C = Chlorides measured

AMMONIA

WHERE . . . In ponds with --

1) High stocking rates

2) High feeding rates

WHEN . . . Worst time --

1) Late summer to mid fall

2) Middle to late afternoon

SIGNS . . . Acute toxicity --

1) Skiddish or spasmodic fish

Chronic toxicity --

1) Lessened feeding activity

2) Retarded growth

CAUSE . . Nitrogen buildup in ponds--

1) Excess feeds

2) Fish wastes

3) Bloom die-offs

4) Bottom mud metabolism

TOXIC LEVELS . . Acute -- Above 0.4 ppm unionized ammonia

Chronic -- Above 0.05 ppm unionized ammonia

Unionized ammonia levels are determined from the total ammonia, using pH and temperature readings with proportion table.

Toxic levels vary with water conditions.

CURE . . . 1) Pumping fresh water

2) If bloom is light use phosphate fertilizers.

3) Lower pH if acute problem occurs.

4) Aerate to maximize oxygen levels.

PREVENTION 1) Don't overfeed.

2) Cut feeding rate from mid-summer to late summer.

3) Drain & dry ponds yearly if possible.

NITRITES

WHERE . . . In ponds with --

1) High stocking rates

2) High feeding rates

WHEN . . . Worst time -- spring & fall when temperatures fluctuate

WHAT . . . Hemoglobin in the blood is oxidized by nitrite and forms methemoglobin which can't carry oxygen.

Fish become oxygen starved.

SIGNS . . . Acute toxicity --

1) Brown blood and gills

2) Fish stress at water surface like they do with low oxygen.

Chronic toxicity --

1) No signs

CAUSE . . . Nitrogen buildup in ponds from:

1) Excess feeds

2) Fish wastes

3) Bloom die-offs

4) Bottom mud metabolism

PROBLEM LEVELS . . Nitrite toxicity occurs when the ratio of chlorides to nitrites drop to less than 7:1.

The brown blood condition occurs when the ratio is less than 3:1.

Other factors including bicarbonate and sodium levels may cause the chloride/nitrite ratios given above to vary greatly.

CURE . . . 1) Aerate to maximize oxygen levels

2) Add salt (sodium or calcium chloride) to pond water to bring chloride/nitrite ratios above 7:1.

PREVENTION 1) Don't overfeed

2) Cut feeding rates mid to late summer.

3) Drain & dry ponds yearly if possible.

4) Put a base level of at least 30 ppm chlorides in pond water.

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PROPORTION OF UNIONIZED AMMONIA IN AQUEOUS SOLUTION AT DIFFERENT pH VALUES AND TEMPERATURES*

	TEMPERATURE °F											
pH	50°F	54°F	57°F	61°F	64°F	68°F	72°F	75°F	79°F	84°F	86°F	90°F
7.0	.0019	.0021	.0025	.0030	.0034	.0040	.0046	.0052	.0060	.0070	.0081	.0095
7.2	.0029	.0034	.0040	.0047	.0054	.0063	.0072	.0082	.0095	.0110	.0127	.0150
7.4	.0047	.0054	.0064	.0074	.0086	.0099	.0114	.0130	.0150	.0173	.0200	.0236
7.6	.0074	.0085	.0100	.0117	.0135	.0156	.0179	.0205	.0235	.0272	.0313	.0369
7.8	.0116	.0135	.0158	.0184	.0212	.0245	.0280	.0321	.0368	.0424	.0488	.0572
8.0	.0183	.0212	.0248	.0288	.0332	.0383	.0437	.0499	.0571	.0655	.0752	.0877
8.2	.0286	.0332	.0388	.0449	.0516	.0594	.0676	.0768	.0875	.1000	.1141	.1322
8.4	.0446	.0515	.0601	.0693	.0794	.0909	.1030	.1165	.1320	.1498	.1696	.1946
8.6	.0689	.0793	.0921	.1056	.1203	.1368	.1540	.1728	.1942	.2183	.2445	.2768
8.8	.1050	.1201	.1384	.1576	.1782	.2008	.2238	.2488	.2764	.3068	.3390	.3776
9.0	.1568	.1778	.2030	.2287	.2557	.2847	.3137	.3442	.3771	.4123	.4484	.4902
9.2	.2279	.2553	.2875	.3197	.3525	.3869	.4201	.4541	.4896	.5265	.5630	.6038
9.4	.3187	.3520	.3900	.4268	.4632	.5000	.5245	.5686	.6033	.6379	.6712	.7072
9.6	.4257	.4627	.5033	.5414	.5777	.6131	.6454	.6763	.7067	.7363	.7639	.7929
9.8	.5402	.5772	.6163	.6517	.6843	.7153	.7425	.7681	.7925	.8157	.8368	.8585
10.0	.6506	.6840	.7180	.7478	.7746	.7992	.8205	.8400	.8582	.8752	.8905	.9058
10.2	.7469	.7742	.8014	.8245	.8448	.8632	.8787	.8927	.9056	.9175	.9280	.9384

Unionized Ammonia (ppm) = Proportion of Unionized Ammonia X Total Ammonium Nitrogen (ppm)

* Adapted from the table in Trussel, R. P. 1972. The percent unionized ammonia in ammonia solutions at different pH levels and temperatures. J. Fish. Res. Bd. Canada 29(10):1505-1507 and in part calculated according to constants and formula in Trussel (1972) and Boyd, C. E. (1979). Water quality in warmwater fish ponds. Auburn Univ. Aq. Exp. Sta., pp 38-40.

OXYGEN, CARBON DIOXIDE, AND SUPERSATURATION

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I. Oxygen (O_2)

A. Introduction
1. Man - 200,000 ppm from air
2. Fish - 14 ppm (maximum) from water

B. General Statements (exceptions)
1. Above 4 ppm O_2 - catfish and bait fish are OK
2. 3-4 ppm O_2 - growth loss
3. 1-3 ppm O_2 - stress (secondary disease likely to occur)
4. Less than 1 ppm O_2 - death

C. Oxygen Saturation
1. *Temperature - rise in temperature/fall in saturation level
2. *Salinity - rise in salinity/fall in saturation level.
3. Barometric pressure - rise in b.p./fall in saturation level
4. *Elevation - rise in elevation/fall in saturation level

At 85 ^oF, 0 ppt salinity, 760 mm Mercury, sea level - 7.5 ppm O_2 (saturation)

At 85 ^oF, 20 ppt salinity, 760 mm Mercury, sea level - 6.7 ppm O_2 (saturation)

At 85 ^oF, 0 ppt salinity, 740 mm Mercury, sea level - 7.3 ppm O_2 (saturation)

At 85 ^oF, 0 ppt salinity, 760 mm Mercury, 4,000 ft. - 6.5 ppm O_2 (saturation)

At 32 ^oF, 0 ppt salinity, 760 mm Mercury sea level - 14.6 ppm O_2 (saturation)

D. Oxygen Users

1. Fish use 1/4 to 3 ppm O_2 per night
a. Size - larger fish need more O_2 than smaller fish

b. Species - trout need more O_2 than catfish

c. Activity - active catfish consume **4** times more O_2 than "inactive" fish

d. Temperature - as temperature goes **up** fish require more O_2

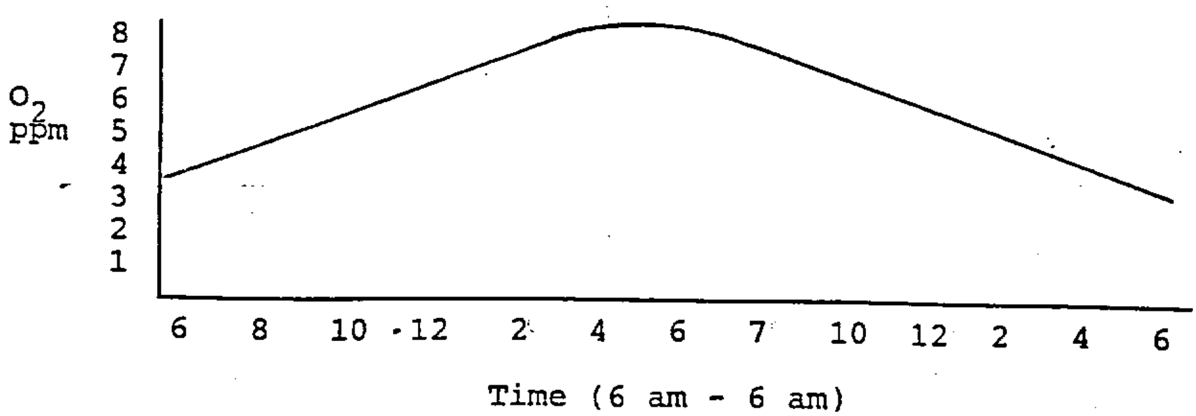
e. Food Intake - after feeding fish require more O_2 - Don't feed in low O_2 situations.

2. Mud Organisms use about 1/3 ppm O_2 per night
3. Microscopic water life (plankton & bacteria) can use up to 7 ppm per night

E. Oxygen Builders
1. Microscopic water life (Phytoplankton) - major O_2 producer and can even produce supersaturation

2. Diffusion - Air-water surface interface
a. Calm waters - little O_2 increase.
b. Moving (wind or paddle wheel) waters - moderate O_2 increase.

F. Oxygen Cycles
1. Daily - high afternoon/low morning

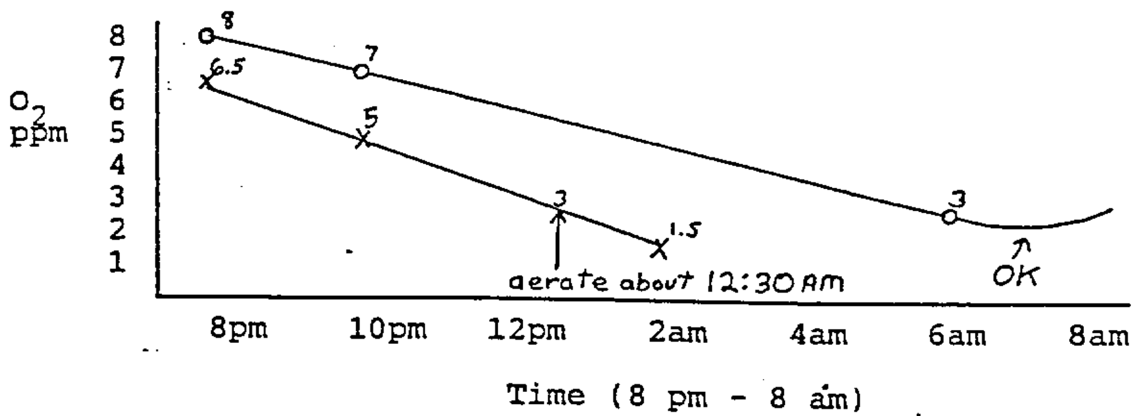


2. Seasonal
a. Summer - worst season for O_2 depletion
(1.) High water temperature
(a.) O_2 less soluble in water
(b.) Fish have higher respiration rate and require more O_2
(2.) Overturns - Ponds stratify with O_2 depleted layer
(3.) Bloom die-offs - decay of organic material results in O_2 depletion

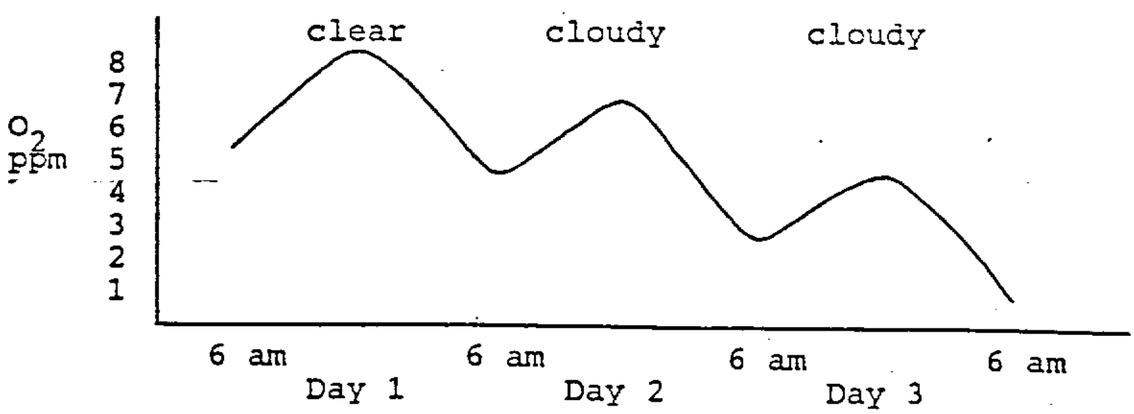
b. Winter - under ice photosynthesis stops and O_2 is depleted.

c. Spring & Fall - few O_2 problems

G. Predicting O_2 Depletions



H. Indicators of O_2 problems
1. Color changes in ponds - black streaks
2. Scum on pond surface
3. Heavy blue-green algal blooms
4. Fish topping in morning
5. Snails crawling out of water
6. Tadpoles topping more than usual
7. Dark stains on light woods
8. Summer cool spells
9. Heavy winds
10. Cold summer rains
11. Cloudy weather



I. Corrective Measures
1. Motor boat
2. Paddle wheel
3. Pumps & others
4. Chemical (potassium permanganate, super phosphate)
5. Caution: Be careful not to stir up pond bottoms if septic conditions exist. Black bottom muds usually should not be disturbed.

J. Preventative Measures
1. Supplemental aeration
2. Lower stocking rates
3. Lower feeding rates
4. Flush ponds with fresh water

K. Oxygen Measuring Devices
   1. Oxygen meters
      (a.) Water calibrated
      (b.) Air calibrated
   2. Oyxgen kits
   3. Light woods
   4. Shad

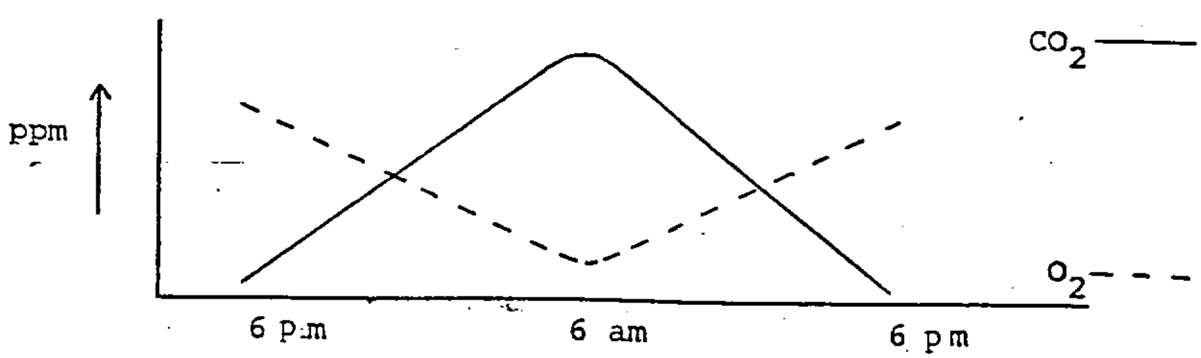
II. Carbon Dioxide (CO_2)

A. CO_2 Producers
   1. Fish - moderate
   2. Microscopic organism in water (night) - heavy
   3. Bottom mud organisms - light
   4. Chemically produced when pH is lowered
      Carbonates ----> Carbon Dioxide + O_2

B. CO_2 Users/Loss
   1. Microscopic organisms in water remove large quantities of CO_2 during the day.
   2. Loss to atmosphere
   3. Rise in pH converts CO_2 to carbonates.

C. Toxic Levels
   1. Catfish - above 35 ppm (Summer)
   2. Golden shiners - 20 ppm or more

D. Daily Cycle - opposite of O_2



E. Affect On Respiration - Carbon dioxide suppress oxygen absorption by the fish. The greater the CO_2 level present the more the O_2 level must be increased for survival.

F. Treatment
   1. Hydrated lime - 25 lbs/acre-ft treats about 10 ppm CO_2
   2. Sodium bicarbonate can raise pH and lower CO_2.
   3. Aeration is not very effective

G. Miscellaneous. - Winter (lower temperatures) - fish can withstand much higher CO_2 levels than in the summer.

III. Supersaturation - Dissolved oxygen or nitrogen in water at levels which exceed saturation

A. Causes
1. Phytoplankton blooms (oxygen supersaturation) - rarely kills fish.
2. Warming calm water (nitrogen supersaturation) - fry may be killed
3. Melting ice (nitrogen supersaturation) - kills all sizes of fish
4. High level water falls (below dams & natural water falls - nitrogen supersaturation)
5. Water pumps which entrap air (nitrogen supersaturation) - fish in holding and hauling facilities may be affected.

B. Smaller Fish Usually Succumb First

C. Indication of Supersaturation Problems
1. Water effervesces
2. Smaller air bubbles collects in water on sides of tank and on objects in tanks
3. Air bubbles appear in the skin, fins & eyes of fish
4. Popeye

D. Corrective Measures
1. Pond - agitation of water is not very effective but the only method that can be used.
2. Tanks
   a. Packed columns
   b. Aeration screens
   c. Aeration towers or steps
   d. Venturi systems
   e. Liquid O_2

MANAGEMENT OF WATER QUALITY PROBLEMS

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Water Quality Problem	Treatment	Comments
Low alkalinity	Calcium hydroxide (hydrated lime)*	Add 20-50 lbs/surface acre then check alkalinity level.
	Sodium bicarbonate	About 3.7 lbs/acre foot will increase the alkalinity one ppm.
	Agricultural limestone	Apply at 1-2 ton/acre to dry pond bottom. For more accurate application rates determine the soil lime requirement every 2-3 years.
Low chlorides	Sodium chloride (salt)	4.5 lbs/acre foot of salt will increase the chlorides one ppm.
	Calcium chloride (anhydrous)	4.3 lbs/acre foot will increase the chlorides one ppm.
Low-dissolved oxygen	Aerate	Aerate until oxygen levels reach 4 ppm.
	Fertilize	May help if bloom is gone.
High pH	Sodium bicarbonate	Add up to 200 lbs/surface acre, then check pH. Limited effectiveness in ponds with alkalinity over 100 ppm.
	Gypsum *	Add 50-100 lbs/surface acre, then check pH.
	Alum *	Add 25-75 lbs/surface acre, then check.
Low pH	Sodium bicarbonate	Add up to 200 lbs per acre, then check.
	Calcium hydroxide *	Add 20-50 lbs per acre, then check.
High ammonia levels	Pump water	Pond or well water may provide a small area of acceptable water to the stressed fish.
	Fertilize	May help if bloom is light.
	Lower pH	See comments for high pH. Not practical in water with high alkinality.
High nitrite levels	Calcium chloride	See rates above. For best results keep chloride to nitrite levels at 15:1.
	Sodium chloride	See rates above.
High carbon dioxide levels	Calcium hydroxide *	About 2.7 lbs/acre foot to remove 1ppm carbon dioxide.
	Aerate	This is only useful if oxygen levels are low.
Hydrogen sulfide poisoning	Potassium permanganate	Put about 5 ppm in area of net landing.
High iron levels	Aerate and filter or settle	The level of aeration, filtration or settlement is dependent on water flow and iron level in water.
	Potassium permanganate	Apply 2-5 ppm in tanks depending on fish species. In ponds, the rate depends on the organic buildup.
Low Hardness	Calcium chloride	See rates above.
	Calcium hydroxide *	About 3.9 lbs gives 1ppm lime/acre foot.

* If the total alkalinity is less than 40 ppm it is best not to use this chemical.