By Dr. Roddy Conrad, October 16, 2002

Introduction: What is an ORP meter?
An ORP meter measures the Oxidation or Reduction Potential of the water. This is a direct measure of "pollution index" of the water, since more pollution gives a lower ORP reading. As described by Chris Walster, a veterinarian at the Island Veterinary Clinic in Staffordshire, England, in the Summer 97 issue of Koi Health Quarterly,
"Put simply, ORP is a measure of pollution. In a well conditioned koi pond you want oxidation reactions to occur, as they indicate the breakdown of water products. Therefore, the higher the ORP level, the less polluted the pond; the lower the ORP level, the more polluted the pond. A low ORP can indicate low dissolved oxygen, high nitrites, or high DOC (Dissolved Organic Carbon), with the DOC promoting the increase of harmful bacteria….A pond with an ORP value below 200 mV will promote growth of slime algae, between 200 and 250 will promote blanket weed or stringy algae, above 250 algae growth will be prevented……As ORP increases, the rate of healing of ulcers increases and at high levels ulcers can be prevented…"

Quick Summary of ORP levels as applied to koi ponds:
At readings of below 150, significant improvements to the filtration of the pond should be made as soon as possible to avoid massive fish health problems.
At readings between 150 to 200, fish health will not be marginal, with green water and slime algae a usual occurrence, especially in the absence of UV lights.
At readings between 200 to 250, fish health will usually be okay, but not optimum, and stringy algae or blanket weed will normally be a problem.
Readings between 250 and 400 reflect good to superb water quality, and prevention of fish health problems by water excellent water quality control. The higher end of this range is preferred over the lower end for dependably good fish health and fast fish growth.
Readings between 400 and 450 reflect the use of either potassium permanganate or ozone to increase water quality by addition of a chemical oxidant to the pond to oxidize the various dissolved organic compounds and solid waste materials on the pond bottoms and in the filter systems. Readings in this range usually do not harm the useful bacteria in biofilters if the length of time is less than 30 minutes in this range.
Readings between 475 and 550 reflect active potassium permanganate levels which should kill fish parasites without harming the fish, and quickly oxidize pollutants, provided the fish exposure is only a few hours per week. Water with ORP in this range should not be circulated in biofilters since the useful bacteria may be oxidized significantly.
Readings between 550 and 600 should not be continued for more than 15 minutes because of likely damage to the gills of fish.
Water with readings above 700 will sterilize a system of all life forms in about 10 to 15 minutes.

Things that increase ORP readings and improve water quality:
Factors to increase ORP
Griff Thomasson's list:
1 Flow rates. Pond turn over at 1.5 hours min. The faster the better for higher ORP readings.
2 Aeration, water falls, TT's, spray bars etc. the more the better.
3 More efficient mechanical filtration, with frequent cleanouts or solid dumps, increase ORP readings.
4 Temperature. Cooler temps will generally give a higher orp reading as there is a higher level of

dissolved oxygen.
5 Fish load. Lower fish loads give higher ORP readings.
6 Heavy feeding gives lower ORP readings.
7 System Maintenance. Clean out filters. Back wash beads filter, rinse filter media in submerged filters.
8 Dead Spots. Find and eliminate dead spots in pond with low flow since this can accumulate solids wastes which lower ORP readings.
9 Add biofiltration capacity to increase ORP.
Good mechanical filtration systems, with frequent dumping of collected solids, goes a long way towards keeping ORP levels up by removing the solid organic pollutants. There are many different ways to accomplish this goal, with many, many good mechanical filter system designs, and it is not the goal of this document to list all those good mechanical filter designs.
Aeration of the water in waterfalls, or with air stones, or with trickle tower filters increase the ORP level of the water by providing more oxygen to oxidize the organic pollutants such as fish poop.
Higher recirculation flow rates increase the ORP levels of the water in various ways. Better solids removal, more aeration, better biofiltration all go with increased water turnover rates.
Using activated carbon to remove DOC (Dissolved Organic Carbon) increases the ORP levels of the water by removal of pollutants from the water. Here the typical charge is 3 pounds of activated carbon per 1000 gallons, changed out with fresh carbon each 3 months. The usual charge is put into mesh bags, laundry bags for example, some place in the filtration system or the waterfall system or stream system. Or even in the actual pond itself.
More biofiltration increases the ORP value of the pond. Trickle tower biofilters do this better by providing a higher level of oxygen to the aerobic (oxygen loving) bacteria which do the biofiltration. But well designed submerged media filters can also deliver superb water quality with high ORP readings.
Addition of low levels of potassium permanganate to increase the ORP reading to the range between 300 and 450 has been beneficial to ponders who have filtration systems which do not automatically maintain water quality in those ORP ranges as a temporary emergency fix of a fish health problem.
Some ponds use ozone injection with on line ORP controllers to maintain ORP levels at a narrow desired range.

A typical example of the low level potassium permanganate treatment option
This low level PP treatment is a way to temporarily increase the water quality and fish health in problem periods.
Below is a table of an actual example of a ponder using low level potassium permanganate treatment to increase ORP level to cure sick fish. The long range fix is to improve the filter system so the water quality stays so high, by ORP reading, that the fish do not get sick.
Here this Massachusetts ponder stopped adding PP on day 8 when the reading stabilized over 300, and the system was clean enough with enough filtration to maintain the reading above 300 for at least another week in that range, giving her two small sick koi enough time to heal at high ORP readings.
This is a typical example of good use of low level PP additions to clean up a pond without bypassing the biofilter. This is a pond with good biofiltration and aeration, but with marginal mechanical filtration.

Day	No PP additions	Total PP added	Starting ORP	Ending ORP	Temp
1	2	.33 PPM	249	261	58F
2	3	.83 PPM	237	467	57F
3	1	.66 PPM	267	416	59F

4	1	.33 PPM	273	446	58F
5	2	.5 PPM	310	481	62F
6	1	.08 PPM	410	468	56F
7	1	.25 PPM	309	473	58F
8	0	0	395		
9	0	0	305		
10	0	0	379		
11	0	0	406		
12	0	0	315		
13	0	0	318		
14	0	0	338		

Example of using ORP readings and a fish log to systematically improve the filter system
Griff Thomasson, on the North Carolina coast, took this log of ORP readings and pond management practices to gradually increase his water quality to higher levels in a highly stocked koi pond.
Today (October 16, 2002) I used a stock solution of PP to raise ORP readings. Storm last night blew over the huge Umbrella palm and ORP readings were in the 250 range from the deposits made by the storm in the koi pond. I mixed up a stock solution of 15 grams of PP in one liter of water and add 200 ml every few hours. ORP never went over 414. It took 5 treatments to get ORP to stabilize in the 300 range. This has worked well as I do not have a high pond turnover rate. I was surprised that it took so much.
Pond log of this 8000 gallon heavily stocked koi pond system with a 1000 gallon vortex settling tank and two large trickle tower filters.
7-14 -02 received orp let orp probe set in pond for 48 hours to settle down
7-16-02 6:30 pm 207
7-17-02 6: am 238, 4 PM 215
7-19-02 culled out 11 fish
7-24-02 4 pm 218
7-24 -02 cleaned settlement chamber 1000 gal water change in 8000 gallon system.
7-25-02 reduced flow through submerged filter. Increased flow to in pond return. Moved some plant stands to get better flow in pond.
7-26-02 6 am 360 5 pm 315 (this swing from morning till night I think is caused by the difference in temp.) Started aeration system running at night on a timer.
7-27-02 Rinsed off water hyacinths for fish to eat and dropped into pond ORP dropped from the 300,s to 85 in less than 30 min??????? Took out hyacinths!
7-28-02 6 am 218
7-28-02 6 pm 267
7-29-02 6 am 331 High temps that day close to 100 deg. Ran aeration during the day when we were not at home.
7-29-02 5 pm 328
7-30-02 5 pm 200 range??
8-1-02 Cleaned settlement chamber 2 PPM PP treatment with HP reversal.
8-2-02 5 Pm 238
8-4-02 7:30 am 380
This period of time I rebuilt my in pond TT and increased flow to 3000 gal per hour.
8-24--02 10:30 am 417

8-25-02 Cleaned settlement chamber PP treatment and reversed with ST. orp 365
8-27 5:30 pm orp 377 temp78 deg
8-29-02 6:30 am 425
9-1-02 6PM orp 435 At this stage I am losing confidence in the probe as the fluid has leaked out and there is a 2" long air bubble in probe. Ordered new probe, received it a few days later.
After making adjustments to pond and management system pond has run in the 300 range. Will drop to the 280 range by day 7 after maintenance. Time to clean out filters.
In September a few leaves have started falling and just a few leaves will drop orp into the lower to mid 200s – note from Conrad – I observed the same rapid drop of ORP reading with leaf fall into the pond.
Comparable notes from Conrad's ponds:
ORP can be stabilized in the 350 to 400 range without the low level PP treatments under the following conditions:
1. When the mechanical filter system is maintained with a low level of trapped solids,
2. With the use of activated carbon in the system for consistent DOC removal
3. With the use of massive trickle tower filters
4. With pond turnover rates at or below a turnover per hour.
Massive leaf fall without quick removal will drop ORP below 300 quickly, sometimes to below 200 if the leaves are left in the system very long.
Conrad uses the low level of PP treatment to increase ORP levels when he does not have time to do a good mechanical filter cleanout when the ORP level drops due to leaf fall or other temporary pond upsets. Conrad also uses the low level PP treatment to prepare his pond for an actual high level PP treatment for parasite control
Use of ORP meters to monitor a high level PP treatment to kill parasites
A remarkable disadvantage of the use of PP to kill parasites is the uncertainty of knowing the actual level of remaining active PP in the water to kill the parasites. The problem is that the PP is frequently rapidly used up by oxidation of DOC and solid crud in the pond system. An ORP meter allows careful scientific control of killing parasites with active PP. The desirable range of active PP is achieved when the ORP reading is in the 475 to 550 range for 2 to 3 hours by continued addition of PP to maintain the ORP reading in that range. In a dirty pond this may require a total of up to 6 to 8 PPM of PP powder, but in a very clean pond which has activated carbon as a part of the filter system this may take as little as 1.5 PPM PP charge.
Note 1: Do not allow the ORP reading to exceed 600; if it reaches that level immediately reverse the treatment with either sodium thiosulfate or hydrogen peroxide.
Note 2: Do not allow the fish to be subjected to water where the ORP reading stays in the 550 to 600 range for more than 30 minutes without immediate reversal with sodium thiosulfate or hydrogen peroxide, to allow longer times at these levels is likely to kill fish by oxidizing the gills.
Note 3: The fish are safe for up to 4 hours at ORP readings in the 475 to 550 range. Longer hold periods may or may not harm the fish, especially at the upper (525 to 550) end of the range.
Note 4: Do not run the high level of PP with ORP readings above 475 through the biofilter since the useful bacteria in the biofilter can be killed.
Note 5: Take out any activated carbon for a high level PP treatment to kill parasites.
ORP meters which have given me good service:
Cat No ORP3 at www.aquaticeco.com is on special currently at $99 and gives good service for a battery driven unit.
Cat No. M35649 is an excellent plug in ORP meter which can be left on line for readings anytime of the day or night. Also it is easy to adjust calibration of this meter. Price $159

Cat No 7022 is required; it is a calibration solution at a 470 mV ORP value. Price $16
Cat No CS is a cleaning solution made to clean the ORP probe if you believe it may be fouled from service. Price $6.95 per pint.
Cat No SS is an electrode storage solution in case you need to store the electrode out of the pond. Price $6.95 per pint.
Cat No SBT is a nicely designed bottle to store electrodes safely; if they dry out, they are useless and can not be regenerated. Price about $3 or $4 each.