

Our 8,000UK/9,600US gallon pond is very much overstocked with Koi up to 83cm/32.6in in length, and growing.



In Japan, it is generally believed that if water hardness is higher than 50 ppm, you should look at ways to soften it.

# Dissolve This

## Total Dissolved Solids Testing

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ell, it would seem that the last article I wrote for *KOI Nations* ([Xxx./Xxx '08?](#)) has roused some interest and debate, pretty much as expected. Water chemistry is something that people in their various countries take for granted and live with. In most of the UK, people generally have hard water, and don't know any different. Because the density of 'obsessed' hobbyists is very light across the UK, those few that live in soft water areas have just found themselves getting phenomenal results, and just shrugging their shoulders as to why their Koi do so well. Of course, there are also many other factors (discussed in the previous article) that also aid in getting good results, so it isn't a case of everyone in soft water areas getting good results.

Likewise, the situation in Japan is basically the same but with results at the other end of the scale. In their case, the Japanese have soft water, as does most of Asia. Many hobbyists just take it for granted that their Koi will grow and blossom with great ease. They don't expect anything different, and the challenge to get great results generally takes little effort. In their case, they just worry about feeding, heat, and filtration. They don't suffer the bottleneck effect of water chemistry.

### Mythical Environments

You see, irrespective of what you might think, Koi are very much genetically 'man made'. The raising techniques, breeding and growing methods, coupled with water chemistry, has led to generations of Koi adapting to the methods and water used to raise them. Taking Koi from Japan, and putting them into a hard water pond in the UK or anywhere else for that matter, is basically moving a species to an environment that it will never really adjust to. It is much the same, as taking Marine fish, and putting them into an aquarium with no salt, or trying to keep Discus in water with a high pH. In the case of these instances, the aquarists wouldn't dream of doing such crazy things, so why do people keeping Koi, not pay such attention?

With Koi there is a myth that the magic of the mud pond lies in its mineral rich soil/water. This is a ridiculous notion indeed! The mud ponds are completely devoid of minerals, and the soil in the bottom of the pond is also devoid of minerals. If the soil were rich in minerals, it would be reflected in the water's hardness, and TDS levels, which are both virtually non-existent. However, the key benefit of mud in a mud pond, is in the bacteria that thrive in it, which help for an eco-system of sorts, and the grubs and shellfish that breed there, which the Koi can forage for all day long if they please. The

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mud itself being mineral depleted, offers no digestive benefit to the Koi whatsoever.

Water in the mud pond may look dirty, but this is caused by algae, and suspended solids (turbidity). This is reflected in the TDS, hardness, and KH levels. TDS (Total Dissolved Solids) levels in mud ponds typically range from around 35-90 ppm. This reading includes GH, KH, dissolved fish waste/organics, and all gases, such as Oxygen, Carbon Dioxide, etc... GH and KH are linked, in that they are measured as 'if they were CaCO<sub>3</sub>'. So, if your water sample has an abundance of Sodium Carbonate dissolved in it, it would result in a high KH reading, but zero GH reading. But, the assumption that the test kit would make, would be that the KH level is perhaps 90 ppm 'if it were present as Calcium Carbonate'. It doesn't mean that it is Calcium Carbonate. Likewise, if you had a sample of water containing a high level of only Magnesium Oxide, it would result in a high GH test result, and zero KH result. But, the high GH result would once again be measured 'if present as CaCO<sub>3</sub>'. You see, as with all tests, there has to be a unit of measurement. If your water contained only Calcium Carbonate, then you would get corresponding test results on both the GH and KH tests. Once again, GH tests look for Calcium and Magnesium ions, and a KH test looks only for Carbonate/Bicarbonate ions.

As previously mentioned, in the UK, the water in most areas is very hard. My own area (Bristol) is one of the hardest. Koi in typical 'Bristol' water barely grow, and frequently suffer from Shimmies, and loss of colour. In Japan, it is generally believed that if water hardness is higher than 50 ppm, you should look at ways to soften it. However, in the UK, there are only a few areas with water as low as this. Bristol water typically has hardness (GH) levels of around 190 ppm. KH levels also run very high at around 11dH/190 ppm, and the result is water with pH levels frequently running around the 8 to 8.4 mark. This kind of pH level has a pretty adverse effect on the long-term condition of Koi. TDS levels of Bristol water are usually somewhere around the 300-335 ppm mark. This figure represents anything and everything that is dissolved in the water, including gases. So, the answer to my problem is Reverse Osmosis. Reverse Osmosis

is a method of stripping out any minerals and organic matter from fresh mains water. A few people have tried conventional ion exchange water softeners, but this doesn't really solve the issues, as they simply ion swap Calcium and Magnesium ions, for Sodium ions. So, you get water with zero GH, but it's still laced with KH, and now with Sodium ions to boot!

My TDS plant strips out everything except H<sub>2</sub>O, and CO<sub>2</sub>. The low levels of CO<sub>2</sub> are very quickly gassed off after leaving the plant. I use this water to try to emulate 'Japanese' water by diluting the hardness in my Bristol water down to an acceptable level. It was actually a Japanese ZNA judge that first led me down the soft water route back in 1998, and insisted that I find a way to soften my water. It was back in 2001/2 that I discovered what was to be the solution to all my problems! You see, we have been keeping Koi since 1993, and dealing since January 2000, and up until this time, I just resided myself to the fact that my Koi would only grow a few cm's each year, and that they wouldn't get big, would get covered in Shimmies and suffer from hard and often disappearing Beni.

I hear many people in hard water areas that claim to get good growth, and that their Koi are in wonderful condition. But this good growth is usually 3-6cm/1-2in each year at best, and the Beni although maybe good for the Koi Show on the younger Koi, it's usually way over the hill on the older/bigger Koi, being too red, and seemingly thin. This is a far cry from what I would call 'great results'. The results I am happy with are the ones that make breeders happy to sell me their top Koi, as they know that I or my clients will get at least as good a result with growth as the breeder could. I class a result as being good, when you can grow a 50cm/19.6in Nisai Gosanke, into the mid 80cm/31in before it is six years old, and to have the condition and colour looking like a million dollars! Anything less, is the result of compromises being taken. Of course, the Koi has to have the right genetics to begin with!

Anyway, that's enough deviation for now... back to the subject in hand! It is virtually impossible to use 'mud pond water' in our fibreglassed and filtered ponds, and this is largely because of stocking levels. It is simply impossible to run the stocking levels that we do, with 'mud pond' water, without crashing the pH.

Raised in 4,400UK gallons measured 62cm/24.4in last summer as a Sansai. Notice what soft water can do for skin quality.

So, we have to find a happy compromise. In my case, I dilute the water at a ratio of roughly 75% RO, and 25% mains. This will generally give me fresh top-up water with a TDS of 80 ppm, KH of around 2.75dH/48 ppm, and a GH level that I don't bother testing, as I feel that lower is better anyway, so long as there is a trace level present.

In the case of my 4,400UK/5,284US gallon pond, I find this water make up pretty much ideal. Particularly, I would usually expect to grow around thirty Nisai of around 50cm/19.6in in spring, to between 60-65cm/23.6-25.5in as Sansai by the end of summer. This loading although not massively stocked, is heavy enough to demand a reasonable degree of KH and pH stability. With main water running at the aforementioned parameters, the pond levels will typically be, a KH of around 1.5-2dh, pH of 7.2-7.3, and TDS around 100-120 ppm. I have found that running it all a little lower offers slightly better results, but at the expense of stability!

You will note that the TDS and KH of this pond water are lower than the water being used to top up. The GH level in the pond is also a little higher than the fresh water, and this is the result of the undigested minerals from the Koi food. This is where TDS starts to get interesting, as the most informative way of using a TDS meter, is to compare pond water, to fresh water. I refer to the difference between these two readings as 'TDS Differential'. This reading is of paramount importance in Koi keeping, as it needs to be regularly checked in order to be certain that water changes are of a suitable level for the feeding/growing regime. You see, if I were to put thirty Tosai in my 4,400UK/5,284US gallon pond, of around 25cm/9.8in in spring, I would perhaps feed 200 grams of food per day, and be topping up with maybe 100 gallons per day, everything may well be fine, and the TDS Differential might be as low as 5 ppm 80 ppm fresh water and 85 ppm in pond equals a difference of 5 ppm. But, one to two months later, the Koi would most likely measure 35cm/13.7in, and be eating perhaps 400 grams of food. In this instance, the TDS Differential will have



risen to perhaps 30 ppm, and continue to rise. Also, this would result in a loss of KH levels.

So, to keep the TDS Differential low, the fresh water influx must be raised during those two months in order to keep the TDS Differential where I want it, and keep the KH adequate. The same Koi, as Nisai of 50cm/19.6in, would be consuming considerably more food, and hence, require considerably more fresh water influx, perhaps 400 gallons per day. With heavy stocking, and heavy feeding, more acids are produced in the pond, resulting in more KH ions being burnt up. Don't be fooled to thinking that this lowered KH level, will mean that the TDS levels will be lower, as they won't! Because of chemical changes within the pond, the KH ions don't just disappear into thin air, they result in chemical changes instead, with TDS levels measuring these changes, in addition to everything else in the water. To my way of thinking, every pond out there should have TDS levels no higher than 50 ppm above the fresh water going into the pond. Any higher level than this, means that you are either overstocked, overfed, under maintained (lack of water changes), or all three!

My 'ideal' with TDS differentials, is between 20-30 ppm above the source water. It is worth pointing out, that although a lower TDS differential is better, it may perhaps take you 10% water changes each week



**This particular pond, (LEFT) had around 320 Koi between 15-18cm in it in December 2006 as Tosai. During last summer, I kept slowly reducing numbers as the Koi grew. Water temperature is now down at 16C/60.8F, and I have reduced the number further, down to about 30 Koi, with the biggest of these now measuring 61cm, and many being over 55cm.**

to maintain a 50 ppm differential, but perhaps 50% changes to maintain a 20 ppm differential! In short, if your pond load is too high, and you can't easily maintain the TDS differential levels that you wish for, then it's time to sell some fish!!! Please don't ever let anyone convince you that TDS meters measure 'salts', as this makes things very confusing! They measure ions, or in short, anything dissolved, including liquids and gases.

#### **Proof Is In The Pudding**

Hopefully the above, will be making sense now, and it will also be starting to come to light, where ORP fits in with all of this? ORP levels on their own serve very little use to the advanced Koi keeper. In fact, when chasing down TDS levels, the ORP meter is pretty much redundant, because by keeping TDS differential levels low, you will be keeping your pond water fresh, and will find that this technique will also result in very healthy ORP readings. ORP readings themselves are very misleading, insofar as firstly, the meters are incredibly unreliable and need constant recalibration. Secondly, ORP readings can be all too easily 'dressed up'.

What I mean by 'dressing up', is that if your TDS meter is telling you that your fresh water is 100 ppm, and your pond is 900 ppm, with you pond water having an ORP of 150 ppm, you may be tempted to go out and throw some Potassium Permanganate in to oxidise the organic loading. You may then be inclined to sit back and smile because your ORP is now 350 ppm, but your water is still laced with fish by-products that need diluting!

As a dealer, my ponds are very heavily stocked. But, I buy many expensive Koi, and can't afford to

lose out by one of these Koi growing a year older, without being a year bigger too. So, if I buy 20-30cm/7.8-11.8in Tosai, these have to grow to between 45-60cm/17.7-23.6in as Nisai. Nisai of 50cm/19.6in have to grow to 60-65cm/23.6-25.5in as Sansai, and Sansai of 60cm/23.6in have to grow to around 70cm/27.5 as Yonsai, in order to keep their 'desirability'. Furthermore, if I sell a good Koi, it is my responsibility to firstly make sure that the hobbyist gets a good result with it, otherwise it will reflect badly on myself for perhaps selling 'Overpriced junk', or will reflect badly on the breeder with people bantering around, 'Oh yeah, I had a Koi from that breeder, but it didn't grow, and turned out crap!'.

The reason breeders sell me Koi that they don't want to, is because they know that one way or another, I will get the results. It's a track record thing. I often tell people this, to help them understand how useful TDS meters are. If you have a pond of 5,000UK/6,000US gallons, with fifty Nisai in it of perhaps 50cm/19.6in each, and good filtration, and then picked up all the Koi, and put them into 1,000UK/1,200US gallons, it would be overstocked! But, if you move the filtration over to the 1,000UK/1,200US gallon pond as well, and do the same water changes that you did on the 5,000UK gallon pond, then the Koi will grow in the same manner as they did in 5,000UK gallons. The TDS meter gives you the information you need in order to manage this. Of course, in the smaller body of water, you will get ammonia spikes after feeding, since the water volume itself won't buffer the levels as well, but I am sure you get my point here.

#### **Changing With The Times**

Most people that first embark down the 'TDS Road' are astonished when they test their ponds for the first time. They usually buy a meter, and pass comments such as, "My TDS should be pretty good, as my pond and filter system are state of the art, regularly maintained, and my water is crystal clear". Yet, when they get home, they are straight on the phone to me in disbelief, that their mains water is perhaps 250 ppm, and yet the pond measures 700 ppm! This is a classic example, of the stocking and feeding levels being increased over the years, with the maintenance levels being exactly the same as when the pond was first built. Another frequently contributing factor is the use of clay additives. Sure, we've all used clays at some time or other, and we have all imagined that our Koi look better for it. But, the problem is, it's a case of 'short term gains and long term losses'. Clays can be useful for brightening the skin of a Koi in preparation for a Show, but that's where the benefit ends. Continued use, will result in elevated GH levels, and hence, harder Beni, that is finished far too early. In Japan, breeders will try to use the mud pond to their advantage in keeping the Beni from finishing. The result is a big Koi, with youthful soft Beni. Finishing up when the Koi is big will result in a far more beautiful, and much longer 'usable life' of the Beni. Beni that is finished too soon will also deteriorate too soon.

A Koi in such condition won't reward the keeper. Clays are a funny subject in themselves, since even in Japan; they are very seldom used when growing Koi. The Koi industry is very much a case of people sitting in a lab thinking of what they can possibly invent or

market, in order to give them a good income for the coming years. It doesn't really seem to matter if the product is good or bad, so long as people buy it. The trouble is, westerners look at what they 'think' the Japanese are doing, and then do it themselves. There's nothing wrong with that in itself, as it's all part of human nature to do what we think best for our pets. But, in Japan, there is at least some sense in people using clays occasionally, for finishing a Koi for a Show. But, please bear in mind, that in my case, rather than adding minerals to my ponds, I am stripping it out!

To have hard water laced with minerals, and then repeatedly add kilo upon kilo of minerals to it, seems absurd. Koi get pretty much all the minerals they need, from their food. Some people are of the opinion, that Koi need GH or other minerals in order to keep the colour attractive, or it will fade and disappear. In response to this, I would usually show them Koi that have been raised in 'super-soft' low-mineral water, as the Koi will do the talking. The BKKS Grand Champion of 2003 grew from 85cm/33.4in, to 93cm/36.6in by 2005, when she won again, in just the kind of water that I favour. This should be one of the prominent examples that people should think about whenever the question over 'hard or soft' water is raised. ■



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