

Using Air and Acid to Get Perfect pH and Alkalinity Quickly

By Robert W. Lowry

It sounds radical and way out there but it's easy to do and it works. Best of all, it uses muriatic acid which is cheap and something that is free – air.

In a typical pool, the pH is maintained at a recommended level of minimum 7.2 and a maximum of 7.8 with the ideal range of 7.4 to 7.6 (per APSP and many health department guidelines). The total alkalinity is maintained at minimum 80 ppm to a maximum of 160 ppm with an ideal range of 100 ppm to 140 ppm.

If the pH and alkalinity are both higher than recommended levels, muriatic acid (HCl 31.4%), dry acid (sodium bisulfate, NaHSO₄), sulfuric acid (H₂SO₄) are added or carbon dioxide (CO₂) is injected to lower them. However, pH is a logarithmic value and total alkalinity is linear so they will not be lowered or raised at the same rate.

High and Low Problem

So a service tech, commercial pool operator or pool dealer is faced with lowering either pH or total alkalinity too much or not enough. If enough acid is added to adjust the pH to the recommended range, then the alkalinity will be too high. If enough acid is added to adjust the total alkalinity to the proper level, then the pH will be too low.

When the pH is a little low (about 7.1 or 7.2) and the total alkalinity is near recommended levels, adding sodium bicarbonate will bring both up to proper levels. However, if pH is low and total alkalinity is OK, there has not been a practical way to raise only the pH.

Yo-Yo Effect

You can't add a strong acid (muriatic) and then later add a strong base (soda ash) and expect the total alkalinity to change. These two chemicals exactly cancel each other out assuming you add amounts to end up at the same pH that you started with. This is the classic "yo-yo" effect though in practice it's even worse because people often use soda ash to raise the pH and that actually increases the total alkalinity even more so you end up with a higher total alkalinity than when you started! The only way to lower TA is to physically remove some of the carbonates in the pool and by carbonates I mean the collection of species that are in equilibrium — carbonate ion (CO₃²⁻), bicarbonate ion (HCO₃⁻), carbonic acid (H₂CO₃) and aqueous (dissolved carbon dioxide).

Carbonate Removal

In theory, one could intentionally form calcium carbonate by over-saturating the water by significantly raising the pH and then physically removing the precipitate. But doing that can cause scale to form on pool surfaces and in pipes and equipment. It is not a precipitate that is easily removed. Also, the high pH can cause metal staining if metals are in the water. If there were a chemical that strongly precipitated carbonate without forming scale, then that would be great (similar to the lanthanum based products that precipitate phosphates for algae control), but there isn't any.

Remove the CO₂

The best way of removing the carbonates in the water is to aerate the water to remove carbon dioxide (CO₂) since the pool is over-saturated in the first place.

Lower Alkalinity and pH With Acid Then Raise Only pH With Air

Lowering the pH significantly will increase the amount of carbonates that are in the form of carbon dioxide in the water and that will increase the rate of outgassing (carbon dioxide leaving the water).

Aeration will also increase this rate of outgassing. As the carbon dioxide outgases, it causes the pH to rise with no change in total alkalinity. You can then add acid to lower both pH and TA with the net effect of having the TA get lowered. **The procedure is to add acid until the alkalinity reaches about 90-100 ppm. Then aerate until the pH rises to 7.4 to 7.6.**

Now, here is what it takes to do this procedure efficiently, the main rule to keep in mind is that **it takes 25.6 fluid ounces of full-strength Muriatic Acid (31.45% Hydrochloric Acid) to lower the total alkalinity by 10 ppm in 10,000 gallons.** The problem is that if one adds enough acid to lower the total alkalinity all at once, then the pH can get too low. However, let's see how low it would actually go in some extreme cases.

Example

For this example, assume there are no borates and that the cyanuric acid is 30 ppm and the pH is starting out at 7.8 (if it's at 7.5 and is stable, then the total alkalinity probably doesn't need to be lowered, but usually high total alkalinity pools are high in pH as well). If one lowers the total alkalinity from 200 ppm to 80 ppm, then the pH would drop to 6.1. If one lowered the total alkalinity from 300 ppm to 80 ppm, then the pH would drop to 5.8. So you can see that even extreme additions of acid to lower the total alkalinity, at least to 80 ppm, don't get the pH much below 6.0. While such a pH is not good long-term, having the pH be that low for a relatively short time of less than a day is not a problem or a disaster. At such a low pH, carbon dioxide will be driven from the water fairly quickly since there is 220 to 440 times more carbon dioxide in the water as the equilibrium amount with air.

Add the Acid

The key to adding such large quantities of acid to the pool is to not overdose in one place as that could damage the plaster. Adding the acid slowly over a return flow with the pump running and then brushing to ensure thorough mixing will prevent the pH from getting too low in one spot potentially damaging the plaster. Obviously, one doesn't want a return fitting pointing up when adding the acid because you don't want it splashing back at you.

Add the Air

Just doing things like pointing the returns upwards and running the pump on high to create surface disturbance will aerate the water reasonably well. If the returns in the pools that are being managed are standard, then one could add an aerator to the return.

If there are waterfalls, fountains, spillovers, etc. then turning those on will also help. Even better would be an air compressor with an end tube with many tiny holes to produce lots of small bubbles and then putting that end into the deep end so the bubbles spend as much time in the water as possible. The idea is to increase the air-water surface area as much as possible.

How Long Will It Take?

As far as predicting how long it will take, I don't have anything but relative qualitative estimates based on how far out-of-equilibrium the carbon dioxide in the water is with respect to air.

My rough guess is that if the full amount of acid was added and the pH lowered towards the 6.0 "limit", that the outgassing would occur fast enough to have the pH rise to 6.5 or so within 1-2 hours even with modest aeration from pointed-up returns. Getting from 6.5 to 7.0 could take longer though still probably within the same day (so 4-8 hours more, most likely). It's getting from 7.0 up to 7.5 that could take longer – over a day or two, assuming that total alkalinity is near 80 ppm, unless there is significant aeration. Of course, that's what you want since that means the pH will become stable. The down side for a service tech is that raising the pH using this method could take many hours or even a couple of days.

Not for Everyone

Most pool owners would probably not attempt such a "drastic" or "scary" procedure, especially if they asked their pool store about it. To which they would likely hear, "Are you crazy?" Professional pool service techs could easily use this method. Acid is not expensive and air is free plus there is not much chance of over-doing the pH raising procedure. As the pH gets near 7.5 it takes more and more aeration to make a change. In fact, it is difficult to raise the pH much over 7.5 with aeration.

It's certainly a heck of a lot better than the "acid column" or "slug" method that more likely results in pooling of acid which can destroy the pool surface in the area where it is added, especially if it's a vinyl pool. In fact, the biggest risk to the procedure described above of going to a 6.0 pH is for vinyl pools since they are far more sensitive to pH than plaster pools. However, I suspect that having just 1-2 hours exposure to a 6.5 pH is not a serious problem. If the total alkalinity drop is limited to increments of 40 ppm, then the pH would not get quite so low. In this case, adding 102 fluid ounces per 10,000 gallons at one time would lower alkalinity by 40 ppm and the pH would not drop below 6.5. Then add air (aerate) before lowering by another 40 ppm. So lowering alkalinity by more than 80 ppm could be done over multiple days or visits.

Accelerating a Natural Process

Just keep in mind that the above method simply accelerates a natural process that will occur more slowly over time anyway. The total amount of acid needed to lower alkalinity would be the same if some is added every week to lower the pH — over time the total alkalinity would slowly drop. The procedure simply speeds up the process. You don't save on the amount of acid you need to add, but you save on the frequency of required acid addition. You basically get it over with in a shorter period of time. This assumes that the total alkalinity isn't increasing over time, but that can also happen with evaporation/refill since the fill water usually has some total alkalinity.

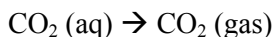
Nature's Equilibrium Method

If you lower the total alkalinity of the pool water to about 90-100 ppm with muriatic acid, then the pH will be too low (usually less than 7.0 and maybe as low as 6.0). However, if you have the total alkalinity at 90 ppm and the pH is low, if you wait a couple of days the pH will go back up to about 7.5 on its own without a change in total alkalinity. Carbon dioxide equilibrium will be reached.

Here is what happens:

- 1. Aeration causes CO₂ to outgas.**

So aqueous CO₂ becomes gas CO₂ and leaves the water:



2. Carbonic acid (H₂CO₃) in the water then creates CO₂ according to this reaction:



3. Bicarbonate (HCO₃⁻) in the water creates carbonic acid (H₂CO₃) according to this:



Net result H⁺ consumed and pH goes up – alkalinity does not increase

pH is a measure of H⁺ (hydrogen ion) concentration. The less H⁺, the higher the pH.

We just want to make this natural CO₂ out gassing and pH rising process go faster.

More Aeration and Turbulence = Faster pH Rise.

Things to Do To Make CO₂ Outgas Quicker

1. Turbulence created by return lines aimed up, waterfalls and spillways
2. Using a pressure washer aimed into the water to create turbulence
3. Aeration from a compressor, leaf blower or shop vac and diffuser disks or manifold with holes
4. Aeration using venturi injectors
5. Using a degasser

Whenever the pH is low and the alkalinity is OK, use air to raise only the pH.

A Word About pH Buffering and Stability

With pH and alkalinity at the proper levels they are fairly stable. Cyanuric acid at 30-50 ppm will act as a buffer to prevent pH from lowering. Now you can add borates at 30-50 ppm to keep pH from rising.

Keep the alkalinity about 80-90 ppm and the pH about 7.5. This level for alkalinity is a little lower than the level usually maintained and recommended but the pH is very stable at this alkalinity with 30-50 ppm of cyanuric acid and 30-50 ppm of borates. The borate works better near 50 ppm.

To increase borates in the water use one these chemicals and amounts:

Borax 7.38 lbs will increase borates by 10 ppm in 10,000 gallons.

Boric acid 4.75 lbs will increase borates by 10 ppm in 10,000 gallons.

Sodium tetraborate pentahydrate 5.63 lbs will increase borates by 10 ppm in 10,000 gallons.

Using Liquid Chlorine Does Not Raise pH

Almost everyone thinks that liquid chlorine raises the pH of the pool water. It doesn't. Liquid chlorine has a net zero affect on pH. It increases pH initially but as the chlorine is used up, the pH goes back down to the same starting pH level. Your pH and alkalinity will stay fairly stable and not change much with liquid chlorine, cal hypo or lithium hypo – they are all net zero pH products.