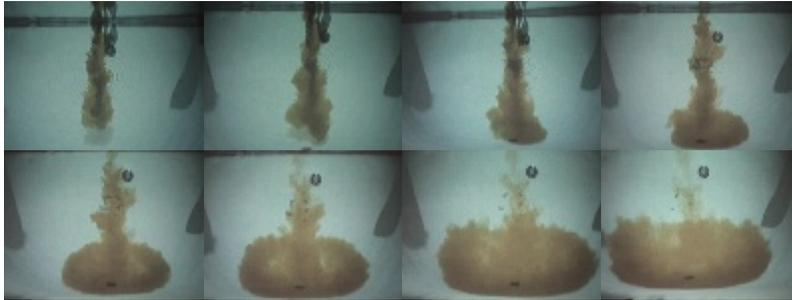


Muriatic Acid and the “Acid Column” Myth



The lowering of Total Alkalinity (TA) and/or pH in swimming pools utilizing muriatic acid has been an accepted procedure in the pool industry for many decades. The reactions involved have been documented and published in widely available texts. However, a myth has seeped into the literature and into chemistry seminars provided to service personnel. This particular myth is that different methods of acid application have the effect of producing different amounts of alkalinity and pH reduction in the pool. Examples of the myth can be found in a Pool & Spa News article, a Service Industry News publication, a water chemistry handbook, and the NSPF course book * and can be summarized:

An examination of the claims show that they do not make sense:

Acid Column Claim: While pouring acid in a localized area, the pH is lowered dramatically in a localized column of the pool water. Yet the claim is that once this low pH column of water mixes in, this acid addition will somehow not significantly lower the pH of the entire pool! Also, somehow the alkalinity of the entire pool will be significantly (or extraordinarily) reduced – reduced by an amount above and beyond what that given amount of acid would normally provide when added by a different method! We are to understand that this skewed effect is somehow – by means of chemical shortcuts – associated with a CO₂ gas-off from the affected column and a hypothetical direct conversion of carbonate to carbonic.

Acid Dilution Claim: When trickling in diluted acid around the pool, the pH of a localized area of water is not lowered significantly; rather, a gradual reduction of the pH is achieved throughout the pool. Yet the claim is that, after mixing, this method will lower the pH of the entire pool water more dramatically, or more effectively than when a column is used! In addition, it is claimed that very little alkalinity reduction will result from this method of application (or if it does, only after a period of time...). Somehow we are to understand that the diluted, dispersed acid does not affect the alkalinity level of the pool the same way acid in a concentrated, localized form would.

Relevant Facts: The following points are key issues which, if understood, invalidate the acid column myth:

1. At normal pool pH levels, there is little or no carbonate alkalinity. The alkalinity is bicarbonate (HCO_3^-).
2. When you add muriatic acid to water, bicarbonate alkalinity is converted to carbonic acid ($\text{HCO}_3^- + \text{H}^+ = \text{H}_2\text{CO}_3$), and is not alkalinity anymore.
3. Although other factors complicate exact calculations for pH reduction, alkalinity is straightforward: A given amount of acid added to a given volume of water will always effect the same alkalinity reduction.
4. Carbonic acid is water and dissolved CO_2 ($\text{H}_2\text{CO}_3 = \text{CO}_2 + \text{H}_2\text{O}$).
5. Although dissolved CO_2 may slowly offgas (depending on what else you do to the water...), this process takes a long time – days or more. Also, there is a balance: CO_2 can also dissolve from the air back into the water.
6. It takes 1600ppm of CO_2 to make bubbles of CO_2 in water. In a pool with 250 total alkalinity, if all of the alkalinity were converted to CO_2 it would only make 220ppm CO_2 . There is never enough bicarbonate in the water to cause the formation of CO_2 bubbles.
7. Although there are some factors, such as pressure or temperature, which make CO_2 offgas faster (try heating up your can of soda pop, or leaving it open for a few minutes...) pH is not one of them.

Testing in pools – Careful experiments were conducted in both vinyl-lined and in-ground plaster pools to verify results under controlled, documented conditions. A pH meter with 3 submersible probes and datalogging equipment was used to verify low pH's as demanded by the acid column method. Initially the alkalinity and pH was increased with sodium bicarbonate, soda ash, and sodium hydroxide to create conditions where the addition of 2 quarts of acid would be a normal procedure. (These same chemicals were used subsequently between tests to reestablish test conditions.) The water was allowed to stabilize, and then the acid was added via the different methods. Tests were also conducted to determine the pH at the bottom of a non-circulating pool after concentrated acid has been added in a localized area. The water was also lab-tested for pH, total alkalinity, total hardness, calcium hardness, total dissolved solids, iron, copper, chlorine, and cyanuric acid.

In the first application method (acid column method) the muriatic acid (with pH-sensitive dye added) was poured into the pool undiluted at a single surface location in a short amount of time with the filtration/circulation system turned on. Acid was poured in the deep end of the pool so that probe #2 would verify the pH of the “acid column”. The dye verified the flow and pH of the acid. Full pH and alkalinity reduction occurred using this method in all repetitions of the test. Although a definite “acid column” (pH lower than 4.0 in a localized, defined area) was created, at no time were there visual bubbles or effervescence.

In the next application method (dilute & distribute method) the dyed acid was poured into a five gallon bucket containing 3 gallons of pool water. This solution was then gently agitated for mixing, and then, with the system running, the acid was dribbled into the pool approximately 18" from the edge, while walking a complete circuit of the perimeter of the pool. Full pH and alkalinity reduction occurred using this method in all repetitions of the test.

Since the second method represented a “best case scenario” of how acid may be added to a pool,

a final application method (acid puddle method) was used for contrast. The location of the probes remained the same. This time the dyed acid was introduced undiluted and in a single location at the deep end of the pool. The circulation system was left off for twenty minutes, and then turned on for the rest of the test period (three days). Full pH and alkalinity reduction occurred using this method in all repetitions of the test. Although a definite “acid puddle” (pH lower than 2.5 in the bowl of the pool) was created, at no time were there visual bubbles or effervescence rising from the puddle.

(NOTE) There are times when pool plaster is intentionally subjected to low pH levels – for example in the case of acid washing the plaster, either with the pool filled or drained. We don’t contend that these processes are detrimental or invalid. The etching or acid-washing of the plaster surface to remove minerals or materials deposited on the surface is done intentionally by professionals using controlled procedures, with care taken to uniformly affect the pool surface. Even spot applications are done intentionally with professional, controlled techniques. We do contend that acid application to etch/clean should be undertaken only when that is the intent and when it is beneficial to do so, but not undertaken inadvertently when the actual intent is only to affect the water balance. Acid column creation subjects random localized areas of the plaster (typically in the deep bowl of the pool) and also the circulation system to etching chemical conditions.

An informal poll of servicemen, builders, and homeowners indicated that not all service technicians will turn the pool system on to help dilute the acid that is added. Some service technicians incorrectly believe that having the pool equipment off will help achieve the lower pH desired in a localized area for maximum reduction of alkalinity. This practice seems particularly dangerous with the advent of newer pools, since many are smaller and shallower, creating a greater potential for damage.

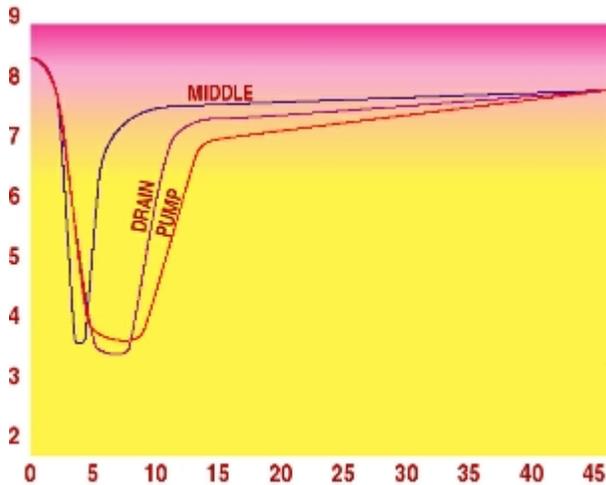
It is unfortunate for professionals (the “experts”) to promote the acid column concept for reducing alkalinity. At what cost is the industry adopting new programs and what amount of risk is the industry willing to take in order to save what, even if the theory had any validity, must be only a few pennies in time and acid?

(Where to go for more detail) An in-depth report of this project is available, which includes a) all of the chemical and mathematical calculations, b) a complete rationale for each point, c) and a complete description of each test pool and method, so that the experiments may be redone by anyone with a good pH meter and alkalinity titration setup. To obtain a copy of the complete report, request Volume 1 Number 2 of the Journal of the Swimming Pool and Spa Industry (520–573–6696).

*** Footnotes:**

- Pool & Spa News, quoting Cal Eden, March 12, 1990, p. 70
- Dickman, David and Lowry, Robert, “Guide to pH, Alkalinity, Water Testing, and Water Balance”, (Service Industry News, 1988), p. 10
- P. Kirk Mitchell, “The Proper Management of Pool and Spa Water”, (Hydrotech Chemical, 1988) pp. 33, 34
- Pool-Spa Operators Handbook, ed. by L. Kowalsky (National Swimming Pool Foundation, 1990) pp. 39, 40

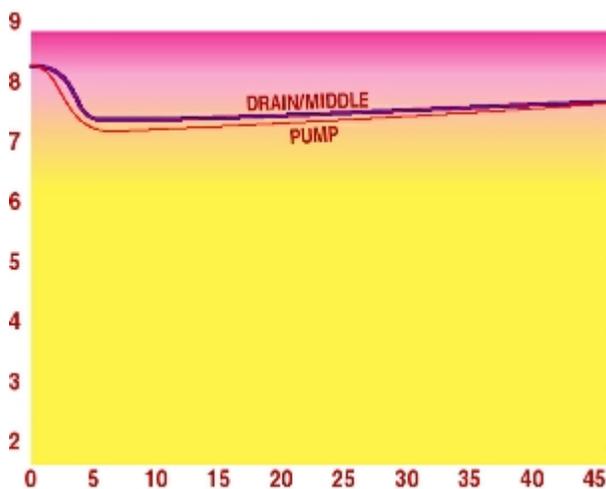
(Additional information regarding this subject appeared in the January 26th, 1994 issue of Pool & Spa News.)



Graph A - Acid Column (Roll-in)

This is a profile of the pH changes when undiluted acid was “rolled in” using the acid column technique, with the filter system on. Probes were located in the hair/lint strainer, on the main drain, and 18" above the main drain. With a starting pH of 8.3 the overall pH drop from the addition of 2 quarts acid in a 11 - 14 thousand gallon pool was approximately .6 pH units. The requirements of the technique call for a localized area of pH lower than 5 (or 4.4). This requirement was met in all three probe locations for periods of 1 to 4 minutes. The acid dropped

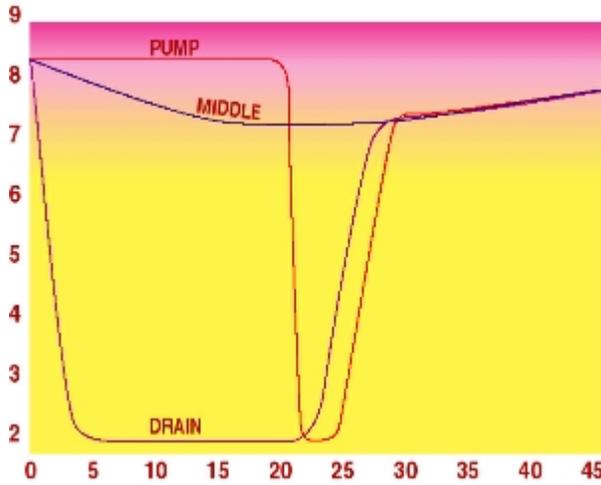
past the middle probe fairly quickly (1 minute or less), puddled briefly (ca. 3 minutes), and slightly diluted into the pump area for about 4 minutes. The pH in all areas of the pool rebounded to safe levels approximately 10 minutes after the acid application. The pH in all three areas rebounded to approximately 7.7 after 45 minutes. The water was in a condition commonly accepted as extremely detrimental to the plaster in the main drain area for over 4 minutes, and in an extremely detrimental condition in the pump area for over 6 minutes.



Graph B - Dilute and distribute

This is a profile of the pH changes when the acid was diluted and distributed around the pools with the filter system on. Probes were located in the hair/lint strainer, on the main drain, and 18" above the main drain. With a starting pH of 8.3 the overall pH drop from the addition of 2 quarts acid in a 11 - 14 thousand gallon pool was approximately .6 pH units. When the acid is sufficiently diluted and “walked around” the perimeter of the pool, the lowest the pH ever dropped was to approximately 7.2 in the pump.

Main drain and middle pH only went down to around 7.4. The pH in all three areas rebounded to approximately 7.7 after 45 minutes. At no time was the pH at a level commonly considered to be detrimental to the plaster or equipment.



Graph C - Acid puddle

This is a profile of the pH changes when the acid was “puddled” on the bottom by adding undiluted acid with the filter system off. Probes were located in the hair/lint strainer, on the main drain, and 18" above the main drain. With a starting pH of 8.3 the overall pH drop from the addition of 2 quarts acid in a 11 - 14 thousand gallon pool was approximately .6 pH units. The pH in all three areas rebounded to approximately 7.7 after 45 minutes. Since the water was static for the first 20 minutes of the test, the acid slipped under the middle probe and only affected it

slightly. The pH at the main drain plummeted immediately to 2.1 and remained there until the system was turned on, at which time the acid puddle was drawn into the pump. As soon as the puddle had passed into the piping system, the pH at the drain and then the pump climbed rapidly with the contact from water drawn from unaffected areas of the pool. The breakdown of the concentrated puddle was minimal until the puddle was drawn into the circulation system. The pH 18" off the pool floor was never low enough to cause harm, but the pH at the bowl of the pool was low enough to be what is generally considered extremely detrimental to plaster for an extended period of time, and presumably would have remained so until water movement from an outside source (pump or brushing) could force the puddled acid apart. The pH in the pump was at a level considered to be extremely detrimental for a 3 to 4 minute period as the slug of acidified water passed through it.

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