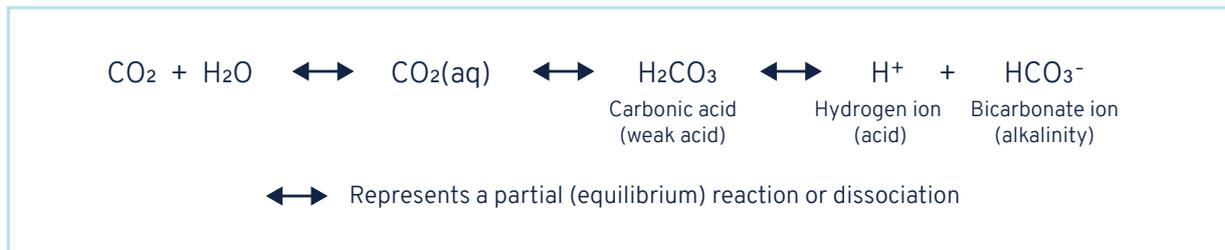


# pH & Alkalinity | How are they related?

## A primer on the relationship between the bicarbonate system & pH

The relationship between pH & alkalinity is intimately connected with the chemistry of the aqueous bicarbonate equilibrium system. An understanding of this will help us to communicate with & understand our customer's needs.



For  $\text{H}_2\text{CO}_3$  dissociation constant,  $k_a = \frac{[\text{H}^+][\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]}$  is a measure of how much it dissociates as a function of  $[\text{H}^+]$  concentration or pH

$[\text{H}^+]$  = concentration of  $\text{H}^+$   
 $[\text{HCO}_3^-]$  = concentration of bicarbonate ion (alkalinity)  
 $[\text{H}_2\text{CO}_3]$  = concentration of carbonic acid (incl. dissolved  $\text{CO}_2$ )

**Taking log of both sides**  $\Rightarrow \log_{10} k_a = \log_{10} [\text{H}^+] + \log_{10} \left\{ \frac{[\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]} \right\}$   
 Reorganising  $-\log_{10} [\text{H}^+] = -\log_{10} k_a + \log_{10} \left\{ \frac{[\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]} \right\}$   
 And by definition  $\text{pH} = \text{constant} + \log_{10} \left\{ \frac{\text{alkalinity}}{\text{carbonic acid} + \text{dissolved CO}_2} \right\}$

## What does this mean for pH control? Take home messages:

1. There are **only** 2 ways to move pH:-

- Add or remove alkalinity
    - To raise pH add an alkali (caustic or MHL -  $\text{Mg}(\text{OH})_2 + \text{CO}_2(\text{aq}) \Rightarrow \text{Mg}^{++} + 2\text{HCO}_3^-$ ) or,
    - To lower pH add an acid ( $\text{H}^+ + \text{HCO}_3^- \Rightarrow \text{H}_2\text{O} + \text{CO}_2(\text{g})$ ) remove **alkalinity** & also adds **CO<sub>2</sub>**.
  - Add or remove dissolved  $\text{CO}_2$ 
    - Dissolve or strip  $\text{CO}_2$  to decrease or increase pH (increase or decrease bottom line)
- Note: in a treatment plant  $\text{CO}_2$  generation is a 'given' as BOD/COD is oxidised to  $\text{CO}_2$   
 $\Rightarrow$  pH will always come down spontaneously even if we dose all influent to  $>\text{pH } 8.5$   
 $\Rightarrow$  system self-corrects - high pH influent can't upset the plant unless greatly overdosed  
 $\Rightarrow$  excess  $\text{CO}_2$  generation is normally stripped by aeration

2. The higher the water alkalinity

- The greater the acid or alkali dose required to move pH up or down.
- The more stable the pH (that's why you need to maintain adequate alkalinity in your pool).