Carbon dioxide for pH control

CO₂ Clean technology for pH reduction
Corrosive acid requires special materials for equipment and piping. Maintenance of systems demands frequent component repairs and replacement. Carbon dioxide (CO₂), on the other hand, is safe to handle, easy to apply, efficient, and ecologically safe.

When pH control is critical to your process or effluent quality, you can trust the CO₂ solution.

Description:
When dissolved in water, CO₂ forms a weak acid: carbonic acid. This substance reacts immediately with alkalis such as caustic soda, sodium carbonate, and dissolved lime, turning them into neutral carbonates and bicarbonate salts.

\[
\begin{align*}
\text{CO}_2 + \text{H}_2\text{O} & \rightarrow \text{H}_2\text{CO}_3 \\
\text{H}_2\text{CO}_3 + 2\text{NaOH} & \rightarrow \text{Na}_2\text{CO}_3 + 2\text{H}_2\text{O} \\
\text{H}_2\text{CO}_3 + \text{Na}_2\text{CO}_3 & \rightarrow 2\text{NaHCO}_3
\end{align*}
\]

Carbonic acid is a mild acid present in water as ions $\text{H}^+$ and $\text{HCO}_3^-$, which are highly reactive. They will immediately react with the $\text{CO}_3^{2-}$ and $\text{OH}^-$ ions that are responsible for the alkalinity of water.

Adding more CO₂ forms bicarbonate ions with a pH of 8.3.
Under lower pH, free CO₂ starts to form with a lower technically feasible pH of ~5.2 under pressurized conditions.

pH Control:
CO₂ is introduced into high-pH water by means of a diffuser and/or venturi nozzle, which are installed in an existing pressurized pipe, a recirculation loop, or at the bottom of a basin. Fine CO₂ bubbles are released by the diffusers and/or venturi and dissolved into the high-pH water.

A pH probe is installed downstream of the gas injection point, measuring the pH of the water after the absorption of CO₂.

A pH control manifold automatically adjusts gas flow and achieves high efficiency and reliability with little supervision from plant personnel.
CO2 VS Acids

For many years, strong acids were used to control pH levels in water treatment facilities, most commonly, sulfuric acid. Acid products do the job, but have many potential problems: acids are difficult to control and are potentially dangerous to store and handle; safety showers have to be installed and made available for operating personnel, who must also wear special protective clothing.

Comparative neutralization curve of mining effluent (660 mg/l CaCO3)

*Acid added (mg/l)*

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<th>H2SO4</th>
<th>CO2</th>
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**CO2+H2O H 2CO3**

**H2CO3+2NaOH Na 2CO3+2H2O**

**H2CO3+Na2CO3 2NaHCO3**

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**Advantages:**
There is no secondary pollution introduced into the treated water by salts such as chlorides (from HCl) or sulfates (from H2SO4).

The introduction of CO2 will contribute to the chemical equilibrium of water by forming carbonates and bicarbonate compounds.

**Supply Modes:**
For small requirements, carbon dioxide can be supplied in liquid cylinders. Larger volumes will be delivered by truck and stored on-site in a bulk CO2 storage tank supplied by Air Liquide. Typically, CO2 is available at a pressure of up to 300 psig and so doesn’t require any pump for its transfer into your process.

**Applications:**
CO2 is used in various industrial waste water processes:
- Pulp and paper
- Textiles
- Cooling towers
- Food plants (cheese, dairy, slaughtering)
- Bottling
- Potable water solids removal and recarbonation
- SAGD boiler blow-down water, tailings, mining
- Dissolved air flotation

**AIR LIQUIDE PROPOSES:**
A pH control system that is safe for the environment
- CO2 is inert and non-corrosive
- CO2 dissipates safely into the atmosphere, leaving no residue to be neutralized
- Acid leaks must be neutralized with alkaline solutions to prevent damage to equipment or the environment
- No special alloy or plastic distribution piping is required for the CO2 system

**Regulation:**
- Eliminate risk of over-acidification

**No maintenance:**
- Components of the system are installed and maintained by Air Liquide’s experienced technical team

**Flexibility:**
- Liquid CO2 can treat streams pH as high as pH 14

These features ensure efficient control and quick reaction to any process pH change or flow variation.
FINDING SOLUTIONS IS IN OUR NATURE

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Air Liquide’s ambition is to lead its industry, deliver long-term performance and contribute to sustainability.

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