2024 Case Study

TOMCO2 SYSTEMS®

CARBON DIOXIDE FOR WATER CHEMISTRY STABILIZATION POST LIME ADDITION

Application:
Lime Softening

- Alkalinity is essential in maintaining a stable finished water quality that minimizes corrosion.

The case study was conducted to utilizing carbon dioxide for water chemistry stabilization post-lime addition.

Challenge:
Low Alkalinity Waters

- Minimal chemical addition of "alkalinity adders" (lime, soda ash) can quickly increase the finished water pH by significantly increasing alkalinity or producing excessively high pH, which results in depositing finished waters.

Alkalinity:
What is Alkalinity?

- The capacity of water to neutralize an acid.
- Most prevalent forms of alkalinity in drinking water system includes portions of the carbonate system, which consists of the three species:
  - Carbonic Acid

  - Bicarbonate Ion
  - Carbonate Ion
- The ratio of carbonate species determines the pH of a solution.
  - The higher the amount of carbonate in a system, the more acid or base is required to change the pH an incremental amount
  - Higher pH = higher buffering capacity
  - The total percentage of the total carbonate shifts to the carbonate ion (CO3 2-), the higher the pH.

Carbonate Ion:

Shifting all carbonate species to the carbonate ion causes precipitation of calcium carbonate, which causes

- Elevated turbidities due to precipitation
- Reduction of pipe diameter due to deposition of calcium carbonate
- Alkalinity reduction due to precipitation of carbonate

Low Alkalinity:

Low Alkalinity situations occur in raw water (Low alkalinity = corrosive water)

- Finished waters that result from the softening of alkalinity-limited waters
- Permeate of nanofiltration or reverse osmosis membranes

Low Alkalinity Problems:

- Red Water
- Corrosion
- Nitrification
- Pitting & erosion of basins

Recommended Alkalinity:

- > 80 mg/L as CaCO3

Carbon dioxide does NOT increase alkalinity; it adds carbonic acid to the system which protonates the carbonate species to become bicarbonate

Options for Alkalinity Addition:

- Quicklime (CaO)
- Hydrated Lime (Ca(OH)2) – Shifts species but does not increase overall carbonate
- Sodium Hydroxide (NaOH)- Shifts the species but does not increase overall carbonate
- Soda Ash (Na2CO3) – Adds alkalinity in the form of carbonate ion (CO3 2-) and the corresponding increase in pH occurs very quickly before the alkalinity increases significantly.
- Sodium Bicarbonate (NaHCO3) – Provides addition of alkalinity without significantly raising the pH, but costs of sodium bicarbonate are higher than other chemicals.

Chemical Needs to:

- Shift carbonate species
- Add more carbonate to the system
- Remain cost effective
- A mix of CO_2 and lime can accomplish this!
  - Enhanced coagulation – Regulations require increased removals of organics for low alkalinity waters. Lower pH increases the removal of organics because organics are less soluble and easier to remove.
  - Softening Process – Carbonate limited water when softened, resulted in finished water with low alkalinity. CO_2 prior to softening is a viable alternative for improving both precipitation process and providing additional carbonate.
  - Nanofiltration/Reverse Osmosis Permeate (NF/RO) – Removes bicarbonate and carbonate, greatly reducing alkalinity. CO_2 added prior to membranes depresses pH of feed water, reducing and eliminating the need for anti-scalents because of the increased solubility of salts in lower pH waters.

Summary:

- CO_2 feed systems allow for instantaneous dissolution of liquid CO_2 & provide a means for depressing the pH in a safe method that, when used in combination with lime addition, can allow utilities to dial in the optimal pH for coagulation and significantly increase pre-softened, coagulated and finished water alkalinity.
- CO_2 addition in combination with lime prior to coagulation allows additional buffering capacity in the coagulation process to minimize basin corrosion while providing an optimal enhanced coagulation pH.