

## ECO<sub>2</sub>MIX – Carbonic Acid Water pH Control For Organic & Conventional Operations

ECO<sub>2</sub>MIX is continually at the forefront of developing new technologies to improve agricultural yields, improve soil health and balance water pH for its producer customers.

ECO<sub>2</sub>MIX offers a unique and proprietary equipment and supply capability aimed at replacement of sulfuric acid or sulfur burners for pH control of irrigation water systems.



The ECO<sub>2</sub>MIX pH control process utilizes dissolved carbon dioxide gas to reduce the pH of irrigation water. As the carbon dioxide is dissolved in the irrigation water it forms carbonic acid and the water pH is reduced depending on the inlet water quality in terms of pH and alkalinity.

### A Review of Sulfuric Acid Injection

Sulfuric acid injection is a well proven method for controlling alkalinity and its effects in irrigation water that has high pH and alkalinity. Sulfuric acid (whether injected as a liquid or produced by sulfur burners) controls carbonate scales and reduces the risk of scaling and plugging of irrigation system emitters.

But what are the disadvantages of sulfuric acid? There are several aspects of the use of sulfuric acid that should give pause to growers:

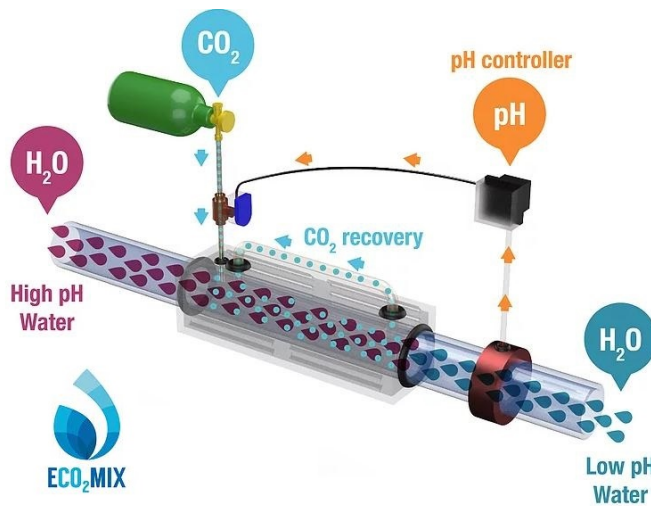
- It is a highly hazardous chemical which is regulated by several federal agencies and the State of California in terms of transportation, storage and handling. The transportation, storage and use of sulfuric acid on a farm requires compliance with these regulations. Spills of sulfuric acid above certain quantities require reporting to state and federal agencies. Sulfuric acid is regulated by the federal DEA as a

drug precursor chemical and quantities must be purchased according to federal or state permits; with storage not accessible to the general public.

- Sulfuric acid is toxic and harmful to human health. It is corrosive to all tissues in the human body (lungs, skin, eyes) and can cause immediate burns and irreversible damage in some circumstances. Proper handling of sulfuric acid requires training of employees and the use of appropriate procedures and protective equipment.
- It is quite corrosive to most metals. Irrigation systems with metal components exposed to sulfuric acid injection will typically have higher frequency of failures of these components; especially if pH control is not effective in preventing very low pH events. The use of compatible materials is essential for all injection system components and areas exposed to poorly mixed acid immediately downstream of the injection location.
- Chemical handling systems (pumps and related equipment) are typically expensive due to the need for compatible materials. Equipment failures are plentiful in these systems, requiring expensive maintenance (again with proper consideration of employee safety).
- If improper mixing occurs, the very high density of sulfuric acid (>15#/gallon) will cause it to flow along the bottom of pipes until it fully dissolves/mixes into the irrigation water. This can lead to high corrosion rates and failures.
- In high concentrations that cause very low pH, sulfuric acid is damaging to plants. Sulfuric acid is an effective alternative to copper sulfate for control of tree roots in underground piping and as such should be considered harmful to tree roots. Certainly, any windborne aerosols of sulfuric acid will cause leaf damage to trees.
- Sulfuric acid will react with calcium in soils to produce calcium sulfate (gypsum). While calcium sulfate has higher solubility in water than calcium carbonates, calcium sulfate solubility is also limited.
- Sulfuric acid is toxic to most soil microorganisms, reducing the most beneficial species population, key participants in soil health and nutrient uptake.

## ECO<sub>2</sub>MIX – A Safer Alternative

The use of an ECO<sub>2</sub>MIX system is a safer alternative to sulfuric acid or sulfur burners. The only inventory to be delivered and stored on site is liquid carbon dioxide tanks. As the carbon dioxide is injected as a pressurized liquid and converted to gas, there are no pumps involved in the system. The carbonic acid formed is not capable of generating a pH as low as can be achieved with sulfuric acid, so corrosion risks, personnel exposure risks and plant health risks are much lower than with sulfuric acid.



The ECO<sub>2</sub>MIX is unique in that it has a carbon dioxide recovery process for any carbon dioxide that is not dissolved in the water. This provides significant efficiency in carbon dioxide usage (100%) and cost compared to other processes available. The process is shown on the image to the left. In combination with the pH measurement and control system, the injection of carbon dioxide provides

excellent pH control of the water, as shown in the following typical pH control chart. The system includes a control panel readout providing continuous display of the treated water pH.

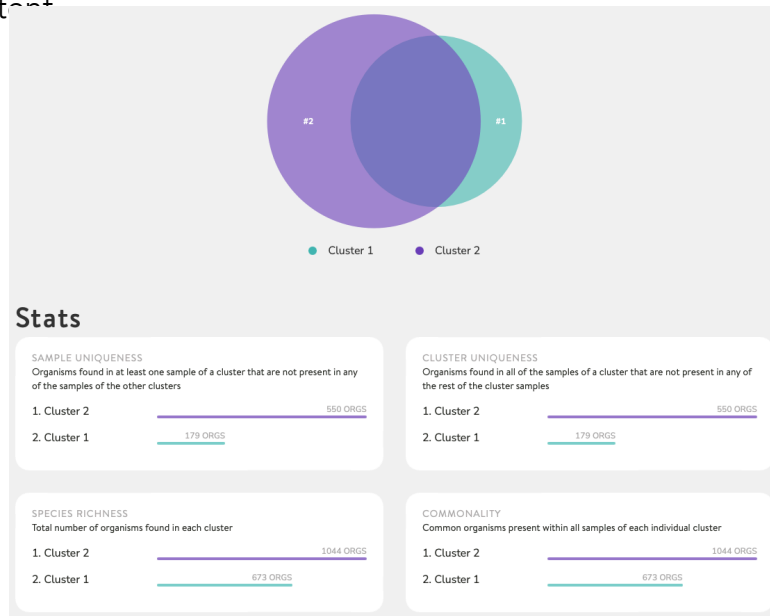


## ECO<sub>2</sub>MIX – Other Benefits

While being a safer alternative to sulfuric acid, it should also be noted that use of carbonated irrigation water can have several additional benefits.

It should be noted that carbonic acid is the acid that plant roots produce to liberate minerals from the soil. Therefore, plant roots exposed to carbonic acid will not experience damage but will find an environment conducive to root growth and expansion of the crop root zone. The additional carbonic acid within the root zone will liberate minerals in a fashion that makes them immediately available for plant uptake. Several studies have shown higher levels of plant tissue minerals in fields irrigated with carbonated water.

Fields irrigated with ECO<sub>2</sub>MIX treated water have demonstrated an abundance of earthworms, leading to improved soil aeration, better moisture penetration and higher soil organic content.



On above image we compare soil samples using the BeCrop test, who run a DNA sequence to identify the soil microorganisms present in the sample, comparing samples taken in March 2021 with samples taken in August 2023, we can see that the population grew from 674 species to 1044 species in that period.



The **ECO<sub>2</sub>MIX Service** is a Monthly Service Charge that provides the customer with use of the ECO<sub>2</sub>MIX proprietary technology, CO<sub>2</sub> tanks, installation costs, maintenance and calibration, and a budget of carbon dioxide gas is also included.

Water alkalinity (bicarbonates), starting water pH determined by water quality information provided, and the amount of water use projected (ac/ft) are important to prepare a proposal, this information help us to know how much carbon dioxide is needed for a particular situation.

The complete list of equipment supplied by is usually composed of:

- Cryogenic tank(s) for CO<sub>2</sub> storage
- CO<sub>2</sub> Vaporization System
- CO<sub>2</sub> Pressure regulation system
- ECO<sub>2</sub>MIX proprietary water pH control equipment

In addition to our general terms and conditions, ECO<sub>2</sub>MIX requires the customer to understand the following special terms and conditions related to the provision of the ECO<sub>2</sub>MIX Service:

- Customer shall not fill the system with carbon dioxide sourced from other parties.
- Customer will be unable to operate the system and shall not receive carbon dioxide refills if payments are not current. Agrosource Irrigation shall have the capability to shut down the system and prevent its operation in the event of customer non-payment.
- Customer shall not perform any repairs or maintenance of the system. All repairs and maintenance shall be performed only by ECO<sub>2</sub>MIX trained service technicians using only approved parts and spares.
- Customer shall be responsible for discouraging and preventing unauthorized access to the ECO<sub>2</sub>MIX system.
- Customer shall not operate any other form of pH control to the irrigation system while the ECO<sub>2</sub>MIX system is in operation.