

# SULFURIC ACID & CARBON DIOXIDE COMPARISON



## **Application:** Enhanced Coagulation

- Provides benefits during challenging water quality episodes where removal of naturally occurring organic material is required
- Lowering pH coagulates this organic material for easy removal

The Central Arizona Project, done in the town of Gilbert, performed a case study comparing two forms of Enhanced Colligation. Those two forms were Sulfuric Acid & Carbon Dioxide.



## **Sulfuric Acid Overview:**

- Liquid chemical delivered as 93% solution
- Delivered in two (2) ways:
  - Truckload - 2,900 gallons
    - Transferred from truck into bulk storage tank with minimal handling by plant staff
  - Totes - 50 gallons
    - Metering pumps pull directly from tote or chemical can be transferred from tote to storage tank using drum pump
    - Requires more chemical exposure than bulk storage system
- Shelf Life
  - Bulk Storage - 5 years
  - Tote or Drum - 2 years

- Capital Cost

Includes two (2) metering pumps, two (2) metering control panels, piping, valves, appurtenances, installation, instrumentation and control, electrical, and contingency.

- Bulk Storage - \$750,000
- Tote or Drum - \$650,000
- Operating Cost Per Month - Include deposit of Tote or Drum
  - Bulk Storage - \$5,200
  - Tote or Drum - \$3,000



### Carbon Dioxide Overview:

- Stored in a refrigerated liquid storage receiver
- Storage tank includes a receiver, refrigeration unit, vaporizer, vapor heater, and first-stage pressure regulator.
- Storage receiver is acquired by one of two ways:
  - Lease from chemical supplier
    - The disadvantage of using a chemical supplier is that obtaining competitive bids for carbon dioxide is not possible – that particular supplier will deliver the carbon dioxide for the duration of the lease.
    - Minimum lease periods may exist which will cost the plant a monthly fee even when tank is not in operation
    - Example: Black & Veatch for Clovis WTP was unsure whether they would require CO<sub>2</sub>. Because of uncertainty, they leased the tank from the chemical supplier and paid for the installation of the leased tank and the monthly rental fee. Clovis found this too expensive and decided to purchase a tank instead.
  - Purchased from manufacturer

- Shelf Life

None! Can be stored indefinitely. In periods of non-use, storage might require energy to operate refrigeration.

- Capital Costs – Include two (2) CO<sub>2</sub> PSFs, CO<sub>2</sub> controls, two (2) booster pumps, piping, valves, piping appurtenances, installation, instrumentation and control, electrical, and contingency.
  - 60 - ton purchase: \$905,000.00
  - 30 -ton lease: \$796,000.00
- Operating Cost Per Month
  - 60 - ton purchased: \$10,000.00
  - 30 - ton leased: \$12,000.00

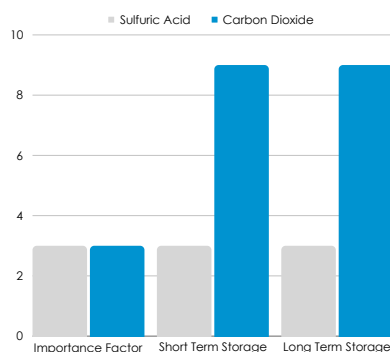


## Evaluation Matrix:

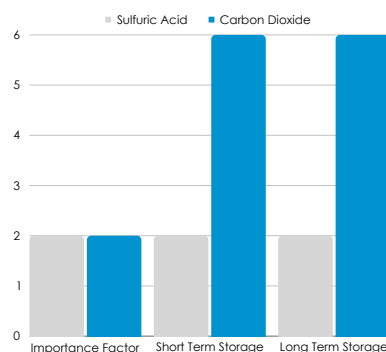
| Criteria                        | Importance Factor | Sulfuric Acid – Long Term Storage | Sulfuric Acid – Short Term Storage | Carbon Dioxide – Long Term Storage | Carbon Dioxide – Short Term Storage |
|---------------------------------|-------------------|-----------------------------------|------------------------------------|------------------------------------|-------------------------------------|
| Safety                          | 3                 | 3                                 | 3                                  | 9                                  | 9                                   |
| Chemical Corrosiveness          | 2                 | 2                                 | 2                                  | 6                                  | 6                                   |
| Capital Cost                    | 2                 | 4                                 | 6                                  | 2                                  | 4                                   |
| Operating Cost                  | 1                 | 2                                 | 3                                  | 2                                  | 1                                   |
| Chemical Availability           | 1                 | 3                                 | 3                                  | 2                                  | 2                                   |
| Short Term Storage Availability | 1                 | 3*                                | 3                                  | 3*                                 | 1                                   |
| Spatial Requirements            | 1                 | 2                                 | 3                                  | 2                                  | 2                                   |
| Water Treatment Effectiveness   | 3                 | 6                                 | 6                                  | 9                                  | 9                                   |
| <b>Total</b>                    |                   | <b>25</b>                         | <b>29</b>                          | <b>35</b>                          | <b>34</b>                           |

\*Since the tanks for these options will be installed during construction, they will be ready for system operation once chemical is delivered. There will not be a waiting period for the short-term storage to arrive.

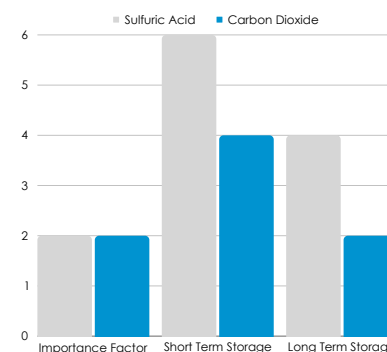
### Safety



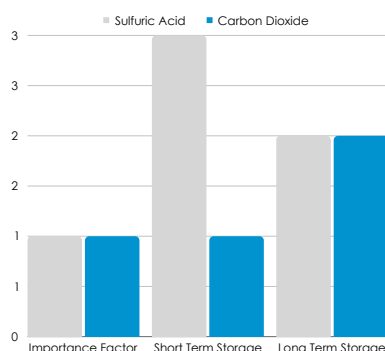
### Chemical Corrosiveness



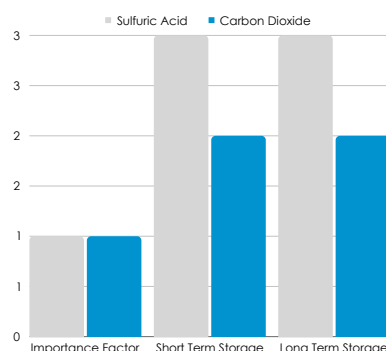
### Capital Cost



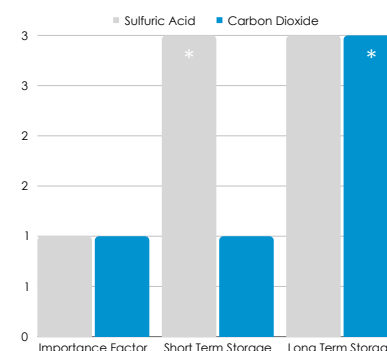
### Operating Cost



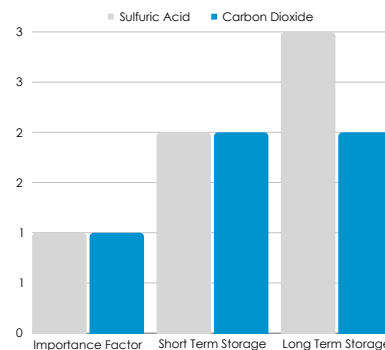
### Chemical Availability



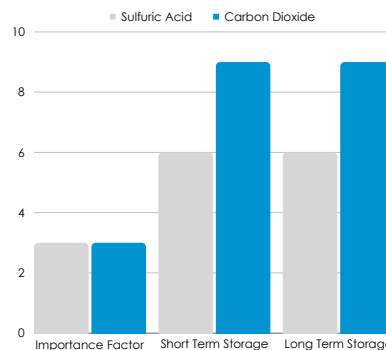
### Short Term Storage Availability



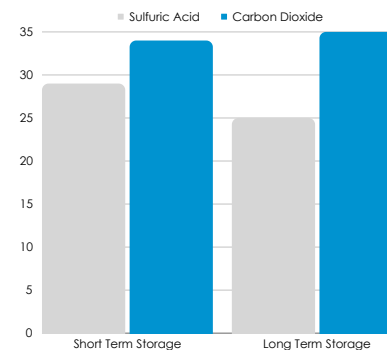
### Spatial Requirements



### Water Treatment Effectiveness



### Total







### Summary:

- Requirements to be considered:
  - In the event of a water chemistry upset, the system needs to come online quickly.
  - If system operation is only required for a short time, storing the remaining chemical should have minimal effect on the equipment.
  - System should be as safe as possible.
  - System should provide optimum water treatment effectiveness.
- Recommended system based on metrics: Carbon Dioxide Purchased System
  - Can be dormant for long periods of time without equipment problems.  
Example: City of Chandler noted that their CO<sub>2</sub> tank was filled and left unused (but maintained) for many years. When the system was brought online, the startup was smooth, and operation was trouble-free.
  - CO<sub>2</sub> does not have a shelf life and can be stored for long periods of time. Refrigeration/vaporizer system will have to operate during that time, but electrical costs will be relatively low.
  - CO<sub>2</sub> is non-hazardous. If tank leak occurs, CO<sub>2</sub> will rapidly dissipate with minimum safety risks to personnel.
  - CO<sub>2</sub> has a positive effect on coagulation without affecting alkalinity.



Scan QR Code for Case Study Document

Original Case Study Author(s):

- Black & Veatch