

Three – year old diversion vault
















The image shows the interior of a large-diameter pipe. The top half of the frame is dominated by a thick, uneven layer of reddish-brown rust that has formed on the surface. This rusted area is surrounded by a grey, peeling concrete lining that has cracked and chipped away in several places. The lower half of the pipe is in shadow, showing the smooth, dark interior of the ductile iron pipe. At the bottom center, there is a circular opening or manhole. Through this opening, a bright outdoor scene is visible, featuring a chain-link fence and some greenery in the background. The overall appearance is one of significant deterioration and corrosion.

One year old ductile iron concrete-lined pipe

So What Are the Options?



- Liquid phase removal options
 - Reduce H₂S in wastewater to prevent release to atmosphere.
 - Nitrate Salts
 - Iron Salts
 - Oxidizers
 - Oxygen
 - Capture sulfides to prevent release to atmosphere
 - Magnesium Hydroxide
 - Calcium Hydroxide
- Vapor phase removal options
 - Remove hydrogen sulfide by passing it through
 - Biofiltration
 - Bioscrubber
 - Carbon Adsorption
 - Wet Chemical Scrubbing



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Caustic Cleaning of Sewer Lines

Liquid Phase Odor Control



Liquid phase options

1. Calcium nitrate
 - Bioxide and Bioxide blends from Evoqua. Two gallons Bioxide/pound H₂S.
 - Aqua Hawk HSX (calcium nitrate) from Hawkins Water Group
2. Oxidizers
 - Hydrogen Peroxide, Chlorine. About 4 mg/L Cl₂/mg/L H₂S.
3. Oxygen Injection
4. Iron Salts
 - Ferric Chloride, Ferrous Chloride
5. pH Shift
 - Hydroxides



Ferric chloride addition





—2400
—2300
—2200
—2100
—2000
—1900
—1800
—1700



Chemical injection site



Nitrate Salt Summary



- Calcium Nitrate or Sodium Nitrate and derivatives
- Very High Degree of Odor Control
 - Easy to optimize
 - Residual nitrate can be easily tested
 - Capable of preventing and removing 100% of sulfides
 - Moderate Cost
 - Non-Hazardous
 - Basic formulations are available nationally. Some blends only available regionally.

Bioxide – Prevention Mechanism (continued)



The end product of microbial respiration

1. Oxygen → Carbon Dioxide and Water
 2. Nitrate → Nitrogen gas
 3. Sulfate → Hydrogen Sulfide
- The presence of calcium nitrate in anoxic wastewater prevents the formation of hydrogen sulfide by providing the microbiology with an “easier to breathe” terminal electron acceptor
 - Without Nitrate:
 - $\text{SO}_4^{=}$ + C → **S⁼** + H₂O + CO₂
 - With Nitrate:
 - 2NO_3^- + 3C → 3CO₂ + **N₂**



2017 Lift Station Corrosion Control Chemical Cost Summary

	Azone	CaNO3	Ferric	NaOH	Total
Haycreek	\$67,153	\$14,486			\$81,639
Pioneer	\$19,903	\$13,779	\$4,229		\$37,912
Southport	\$2,321	\$1,413		\$80	\$3,814
Eagle Crest	\$2,886	\$2,856		\$80	\$5,822
Airport	\$13,352	\$2,560			\$15,912
Total	\$105,615	\$35,095	\$4,229	\$160	\$145,099

	\$/Gallon
2018 Azone	\$4.42
2018 CaNO3	\$4.84
2018 Ferric	\$2.15

Bioxide – Removal Mechanism



- If hydrogen sulfide is already present at the location where calcium nitrate is added, the microbiology can remove the hydrogen sulfide.
 - $8\text{NO}_3^- + 5\text{H}_2\text{S} \rightarrow 5\text{SO}_4^{2-} + 4\text{N}_2 + 4\text{H}_2\text{O} + 2\text{H}^+$
- The reaction requires about **90** minutes of contact time to complete

Bioxide – Application Guideline



- Bioxide is best used:
 - At pump stations and along forcemain injection points
 - For retention times ranging from 1.5 to 12 hours
 - When chemical safety is a concern
 - When hydrogen sulfide goal is very strict

Iron Salt – Product Line Summary



- Iron Salts are available in a variety of blends:
 - Ferric Sulfate and Ferrous Sulfate
 - Ferric Chloride and Ferrous Chloride
- Lesser Degree of Odor Control
 - Acidity of solution drives sulfide out of solution
 - Only capable of removing existing sulfides
- Iron Salts remove sulfide from solution by combining with them and forming a solid. Precipitated metal sulfides are very insoluble
 - $\text{Fe}^{2+} + \text{HS}^- \rightarrow \text{FeS} + \text{H}^+$
 - $\text{Fe}^{2+} + 2\text{Fe}^{3+} + 4\text{HS}^- \rightarrow \text{Fe}_3\text{S}_4 + 4\text{H}^+$

Bismarck WWTP Vapor Phase Odor Control



Humidifier

MAR 12 2009



Biofilter for Odor/H₂S Removal







Bobcat
S300















