

Hydrogen Sulfide Control Methods

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What Is It - How Does It Affect Us? Complaints vs. Compliments!



Smell something - "Dial It Up"

Hydrogen Sulfide aka “Sewer Gas”

- Colorless
- Toxic
- Highly flammable gas
- Foul rotten egg odor
- Breakdown of organic matter by bacteria



Why The Concern?



Why The Concern?

Low Levels

- Irritation to eyes, nose, throat and respiratory system
- Severe headaches
- Fatigue

Moderate Levels

- Severe irritation to eyes, nose, throat and respiratory system
- Dizziness and confusion
- Nausea and vomiting
- Difficulty breathing
- Possible loss of consciousness

High Levels

- Seizures and convulsion
- Inability to breathe
- Possible death

Why The Concern?



10 ppm = 1/1000 of 1%

Can smell. Safe for 8 hours exposure.

100 ppm = 1/100 of 1%

Kills smell in 3-15 minutes. May sting eyes and throat.

200 ppm = 2/100 of 1%

Kills smell quickly. Stings eyes and throat.

500 ppm = 5/100 of 1%

Lose sense of reasoning and balance. Respiratory paralysis in 30-45 minutes. Needs prompt artificial resuscitation. Will become unconscious quickly (15 minutes maximum).

700 ppm = 7/10 of 1%

Breathing will stop and death will result if not rescued promptly. Immediate artificial resuscitation is required.

1000 ppm = 1/10 of 1%

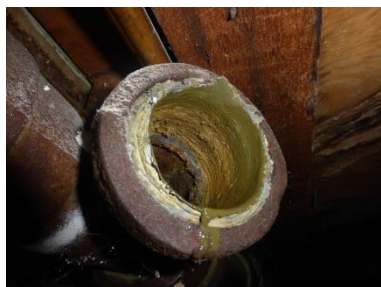
Immediate unconsciousness. Permanent brain damage may result unless rescued promptly.

Why The Concern?



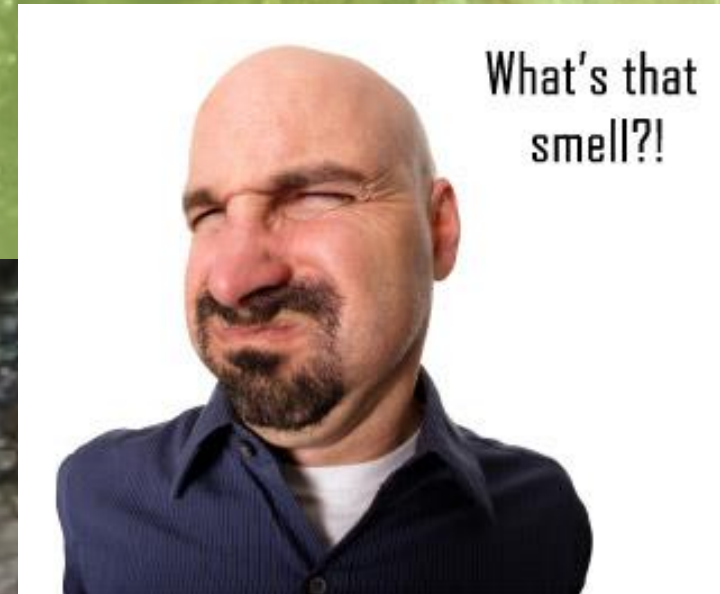
Odors and Corrosion are a Growing Concern for Wastewater Utilities

- Housing development encroaching on WWTPs
 - Suburban
 - Urban
- Water conservation and decreased I & I increases BOD and lowers flow:
 - Increased odors
 - Increased corrosion
- Aging infrastructure and desire to extend asset life by reducing sewer and equipment corrosion rates



Impacts of Hydrogen Sulfide Release

- Corrosion of sewers and treatment plant facilities
 - H₂S converted to highly corrosive sulfuric acid
- Health and safety
 - Workers
 - Public - migration through dry traps etc.
- Nuisance Odors
 - Collection system
 - Wastewater treatment plants

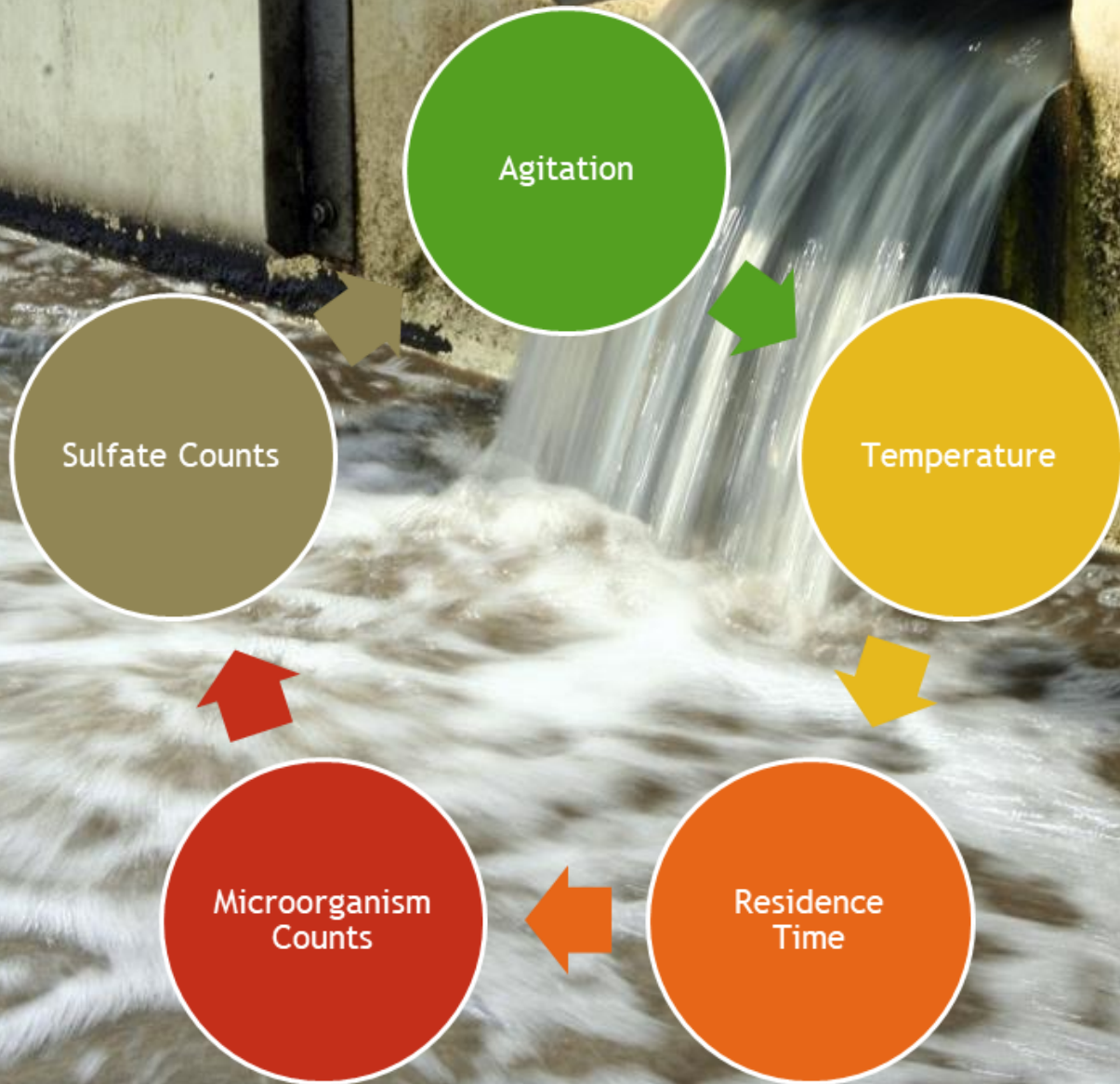


Generation of Odors

Most wastewater odors caused by sulfides

- **Generation of sulfides in sewers in simple terms:
Sulfate (SO_4^{2-}) + Anaerobic Bacteria Sulfides**
- **Sources of Sulfates**
 - Potable water
 - Ground water infiltration into sewers
 - Sulfates from industrial, commercial and domestic source
- **Sulfide generation almost always not limited by amount of sulfates in wastewater**

Generation of Odors

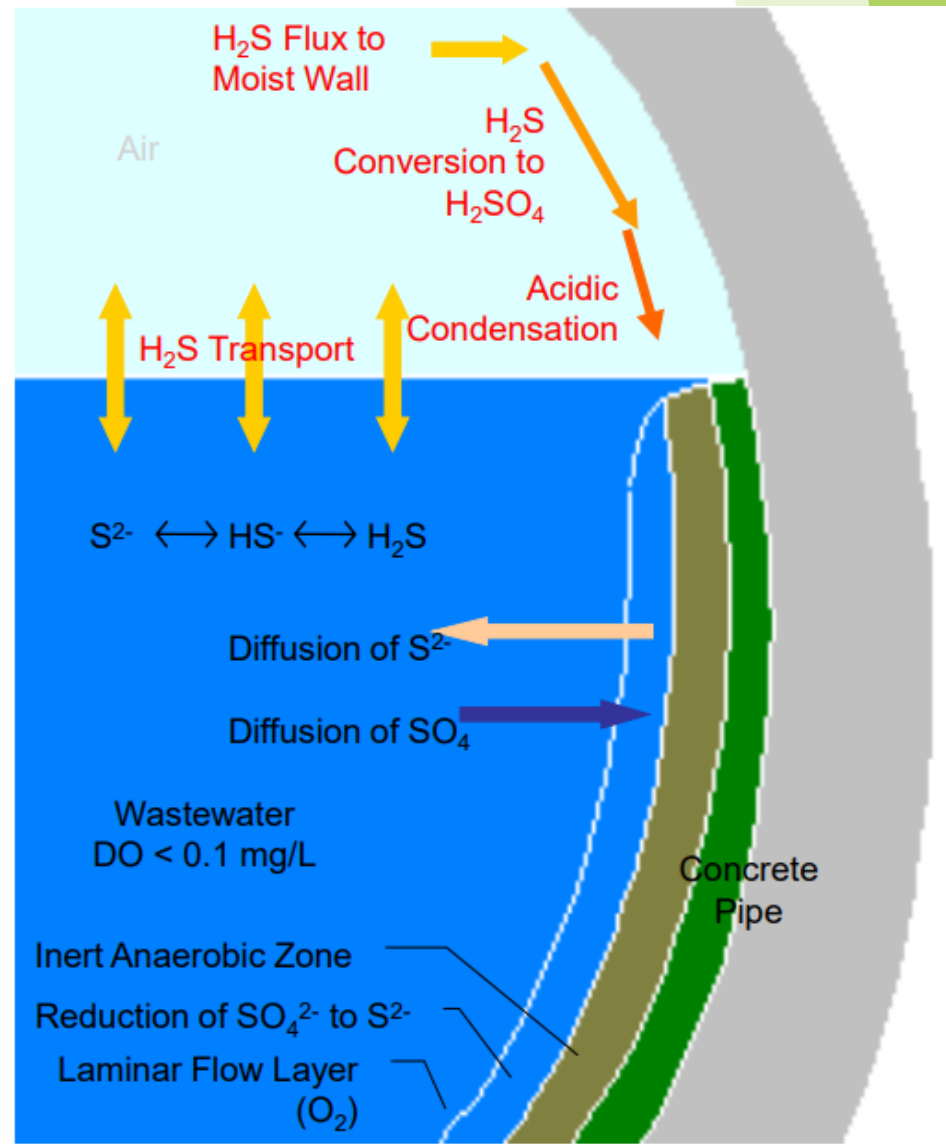


Sulfide Generation in Sewer Pipes (simplified)

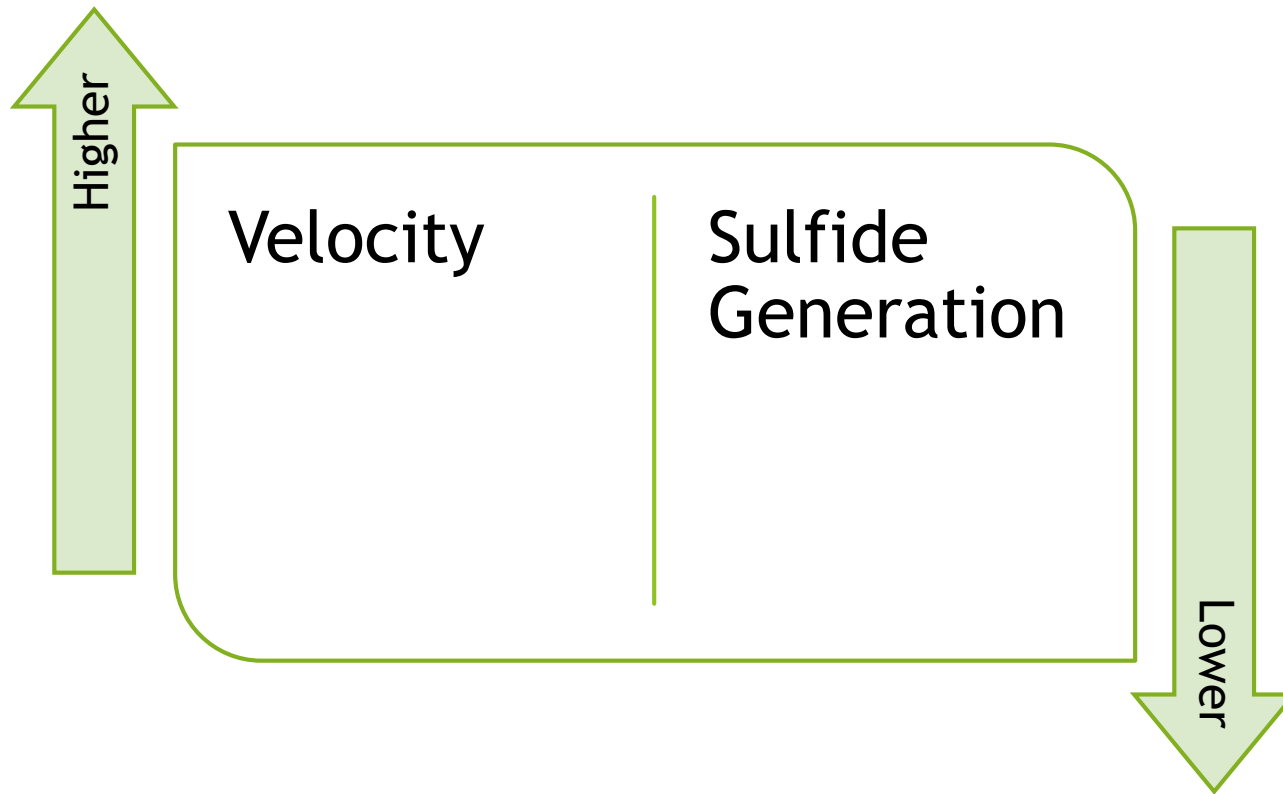
Sulfates converted to sulfides
in anaerobic zone

Oxygen in aerobic zone
oxidizes these sulfides

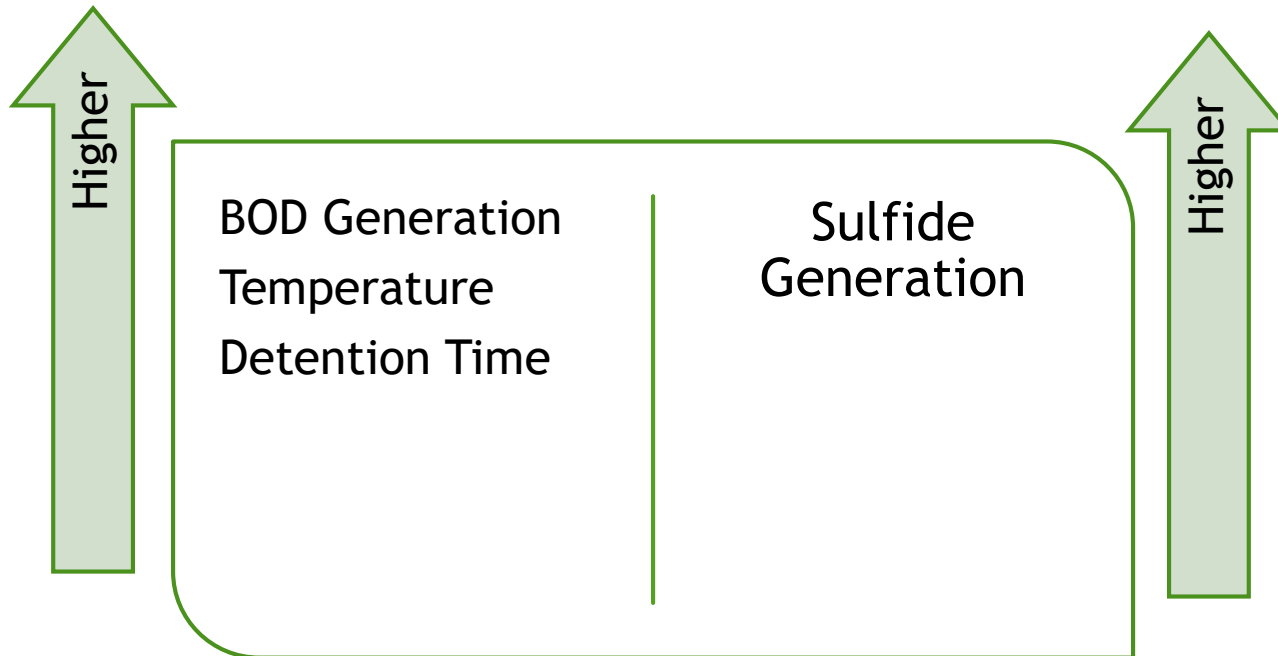
When oxygen insufficient
($<0.1 - 1.0$ mg/l),
sulfides diffuse into wastewater



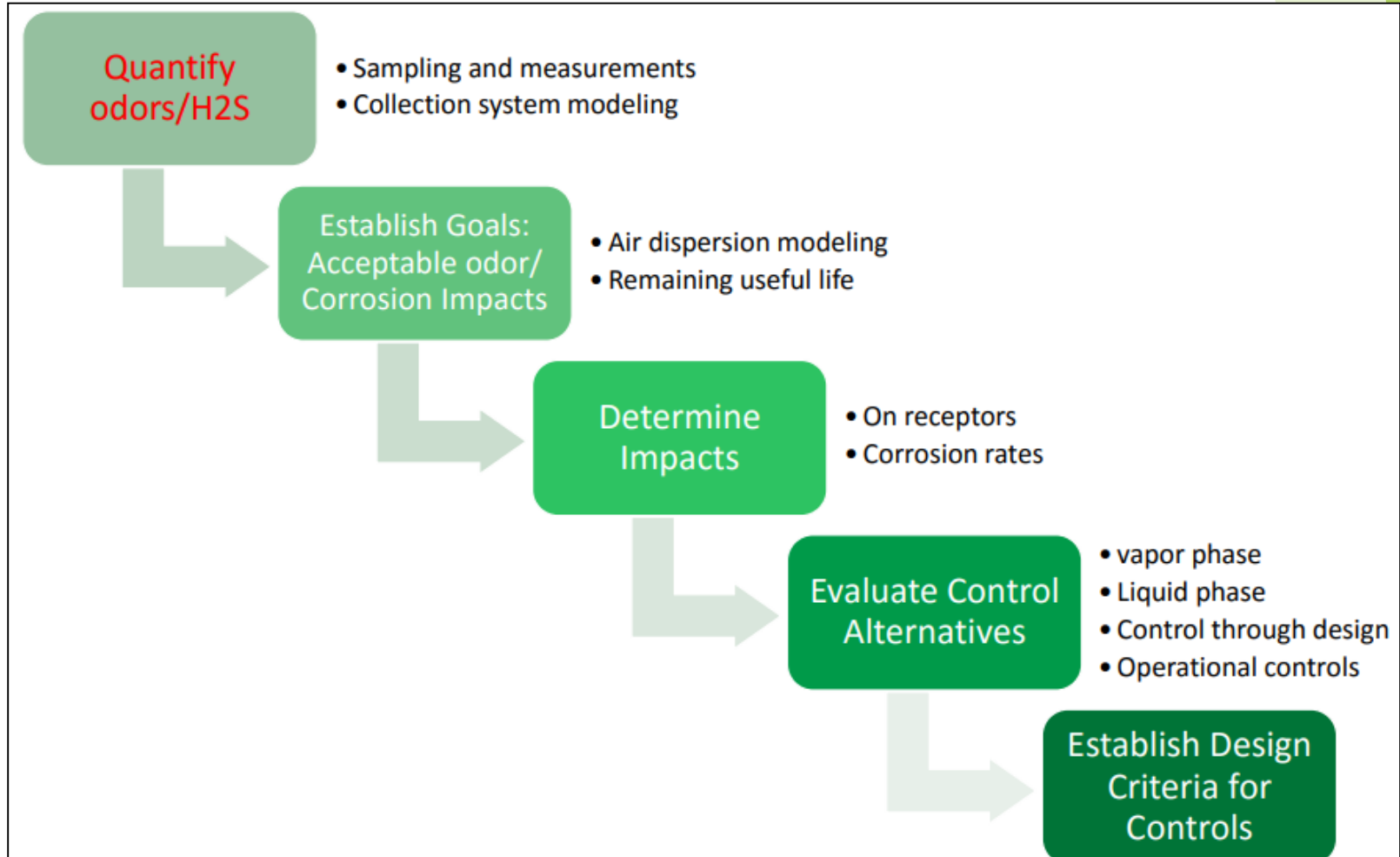
Parameters That Effect Sulfide Generation



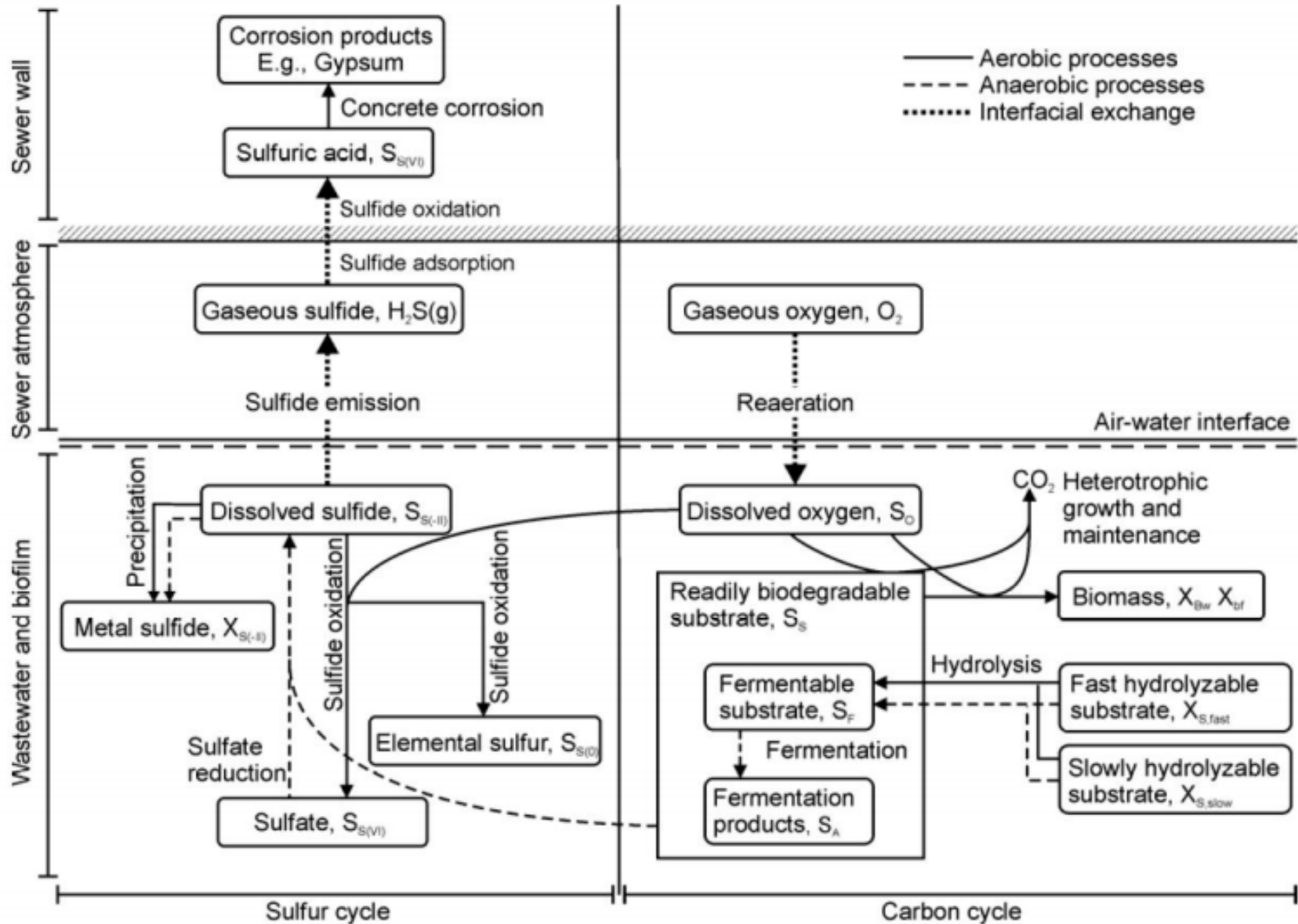
Parameters That Effect Sulfide Generation



Approach to Treatment



Collection Systems: Odor and Corr.



Data Collection and Analysis



Collect data

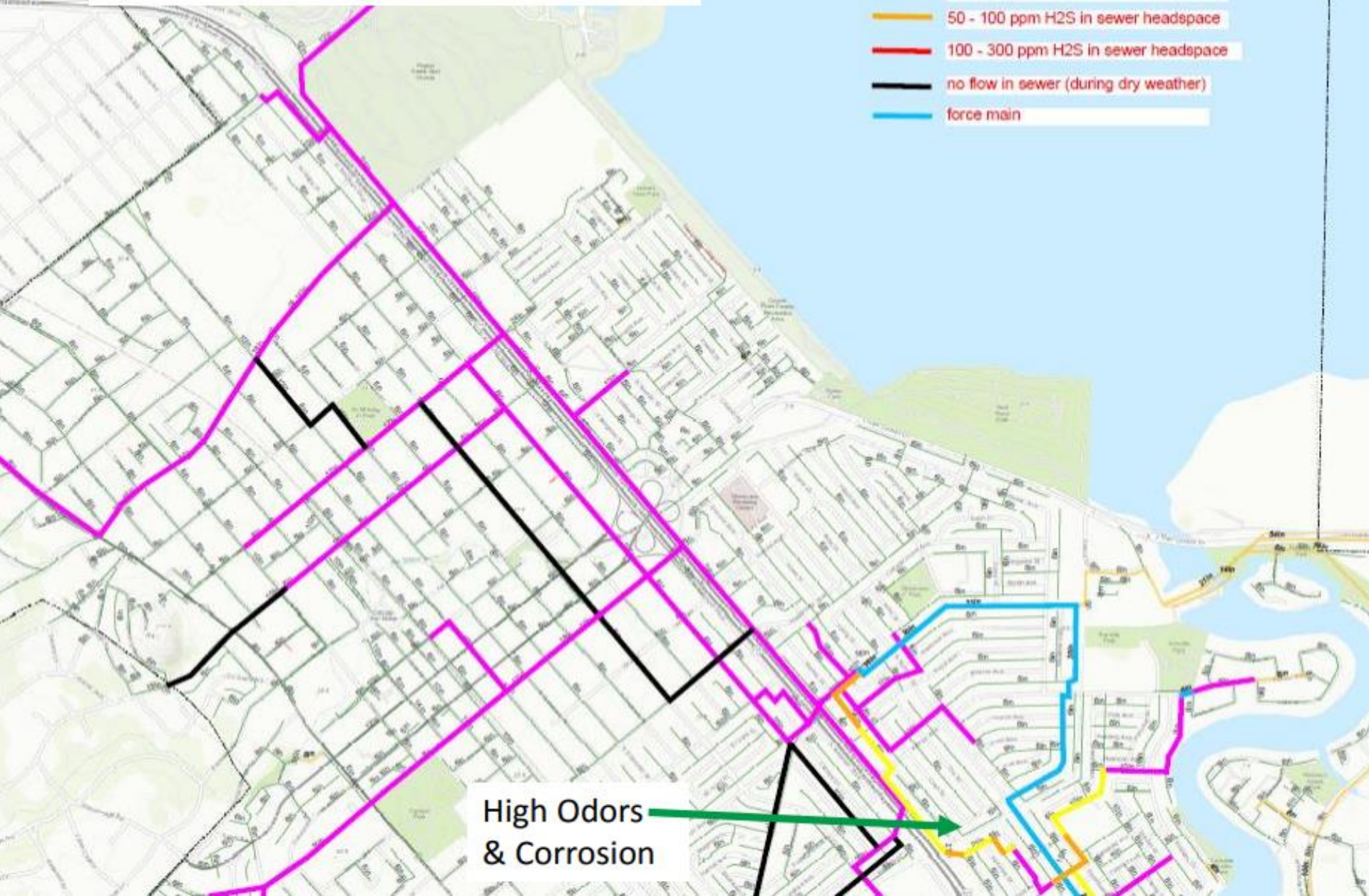
- OdaLoggers
- Surface pH readings
- Flow rates

Analyze data

- Highest H₂S readings
- Highest pH (corrosion) readings
- Lowest Flow Areas
- Longest Detention Times
- Contributors near by (industrial)

Collection System Odor & Corrosion Model Results

- <10 ppm H₂S in sewer headspace
- 10 - 50 ppm H₂S in sewer headspace
- 50 - 100 ppm H₂S in sewer headspace
- 100 - 300 ppm H₂S in sewer headspace
- no flow in sewer (during dry weather)
- force main



High Odors
& Corrosion

Options for Corrosion & Odor Control

DID YOU READ MY TECHNICAL RECOMMENDATION?

NO. IT'S TOO LONG AND COMPLICATED.



Dilbert.com DilbertCartoonist@gmail.com

HOW DO YOU PLAN TO MAKE A DECISION WITHOUT READING IT?

I'LL USE MY GUT.



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IT'S PROBABLY A GOOD IDEA TO KEEP YOUR BRAIN OUT OF THIS.

QUIET! IT'S SAYING SOMETHING.

GROWL



Options for Corrosion & Odor Control

Vapor Phase

Biotechnology (biofilter, biotowers)

Carbon Adsorption

Thermal Treatment

Chemical Scrubbers

Ozone and Ionization

Containment

Ventilation

Collection and Treatment

Multi-Stage Treatment

Liquid Phase

Oxidation

- Hydrogen Peroxide
- Chlorine (hypo)
- Permanganate
- Oxygen Injection
 - Air
 - Nitrate
- Microbial fuel cells
- Slow release solid phase oxygen

Change Equilibrium

- Magnesium hydroxide
- Lime

Sequestration

- Ferrous
- Ferric
- PRISC
- pH Control

Inhibition

- Free Nitrous Acid
- FNA + H₂O₂
- Calcium Nitrate
- Anthraquinone
 - Enzymes
- pH Shocking
- Molybdate

Prevention Through Design

Maintain Velocities

Reduce Points of Turbulence

Control/Alter Ventilation

Line Pipes

Concrete Additives

Air Jumpers

Vapor Phase Control

- Biological
- Activated sludge
diffusion
- Thermal Treatment
- Wet/Chemical Scrubbers
- Ozone
- Photoionization
(UV/Carbon)



Odor Control - Liquid Phase (Chemicals)

Many options to choose from, best option will depend upon:

Wastewater characteristics

- EX: metals will precipitate with iron/impact iron effectiveness

Local chemical prices

Operating barriers (hazmat chemicals/safety)

Downstream impacts at WWTP:

- Additional solids production
- Benefits of precipitation
- VFA production in sewers/impact on bio-P

Prevention Through Design

Prevention through proper design
will always be the lowest cost!

DID YOU KNOW???

Preventative maintenance coatings
to protect infrastructure add layer
to prevent corrosion and will
“stop time”

Magnesium Hydroxide Surface Spray

- lowers surface pH
- protective layer between
concrete and acids
- spray at release points
(manholes, wet wells)

Prevention Through Design

Maintain Velocities

Reduce Points of Turbulence

Control/Alter Ventilation

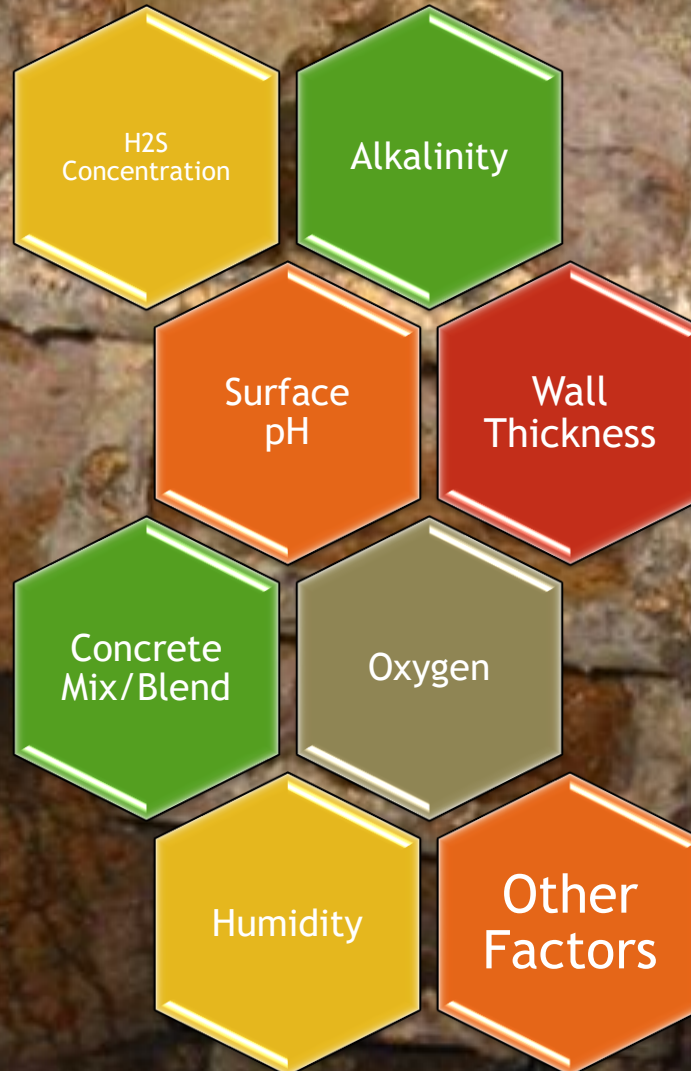
Line Pipes

Concrete Additives

Air Jumpers

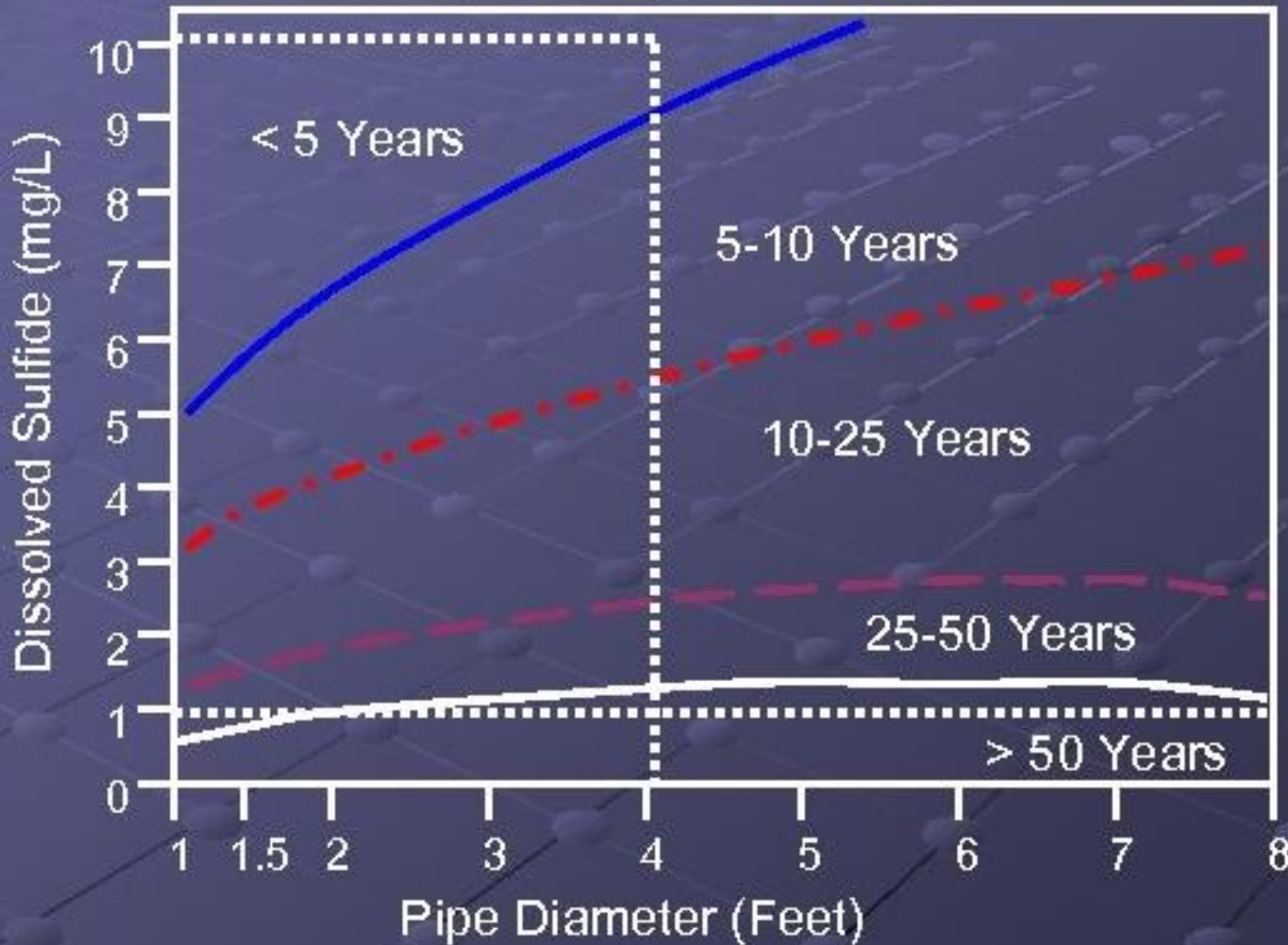
Corrosion Control

Corrosion rate is dependent on multiple factors

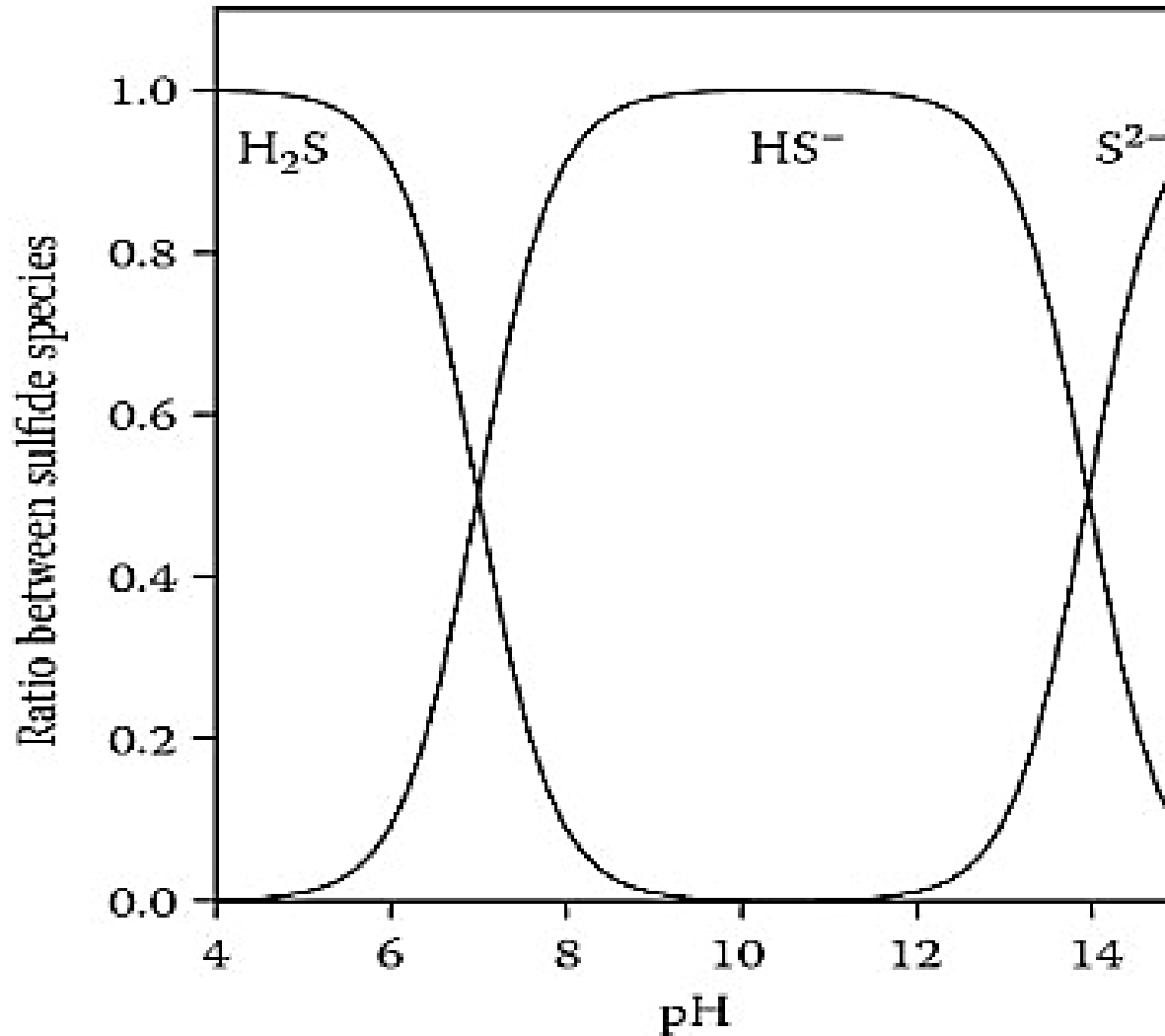


Impacts of Hydrogen Sulfide Release

H₂S Vs the Life Expectancy of Reinforced Concrete Pipes



Sulfide Species are a Function of pH



Factors that Affect H₂S Release

Generation

- Organic Material (BOD)
- Dissolved Oxygen (DO)
- Temperature

Release

- pH
- Turbulence

Common Liquid Treatments



Precipitants



Oxidizers

- Chemicals
- Oxygen



Nitrates

- Calcium Nitrate
- Aluminum Nitrate

Common Controls Odorous Air Treatments



Carbon Absorbers



Biological Treatment

- Bioscrubber
- Oxygen



Chemical Scrubbers

- Calcium Nitrate
- Aluminum Nitrate

Chemicals Used for H₂S Control

Most Common:

Bioxides / Calcium Nitrate

Iron Salts

Magnesium Hydroxide

Sodium Hydroxide

Chemical Treatment

Advantages

- Ease of installation (often turnkey)
- Low capital cost (typically)

Disadvantages

- High annual costs
- Some chemicals hazardous to handle
- Deliveries of chemicals hard in some areas (neighborhoods)

**Closer added to the wwtp =
more careful considerations**

Liquid Phase Treatments

Precipitation

- Iron Salts

pH Elevation

- Sodium Hydroxide (shock treatment)
- Magnesium Hydroxide

Prevention

- Nitrate formulations

Oxidation

- Air injection
- Oxygen injection
- Hydrogen peroxide
- Sodium hypochlorite
- Potassium permanganate

Iron Salts

Chemicals used

- Ferrous/ferric chloride
- Ferrous/ferric sulfate

Removal mechanisms

- Bind with dissolved sulfide and precipitate
- Reduce Sulfate Reducing Bacteria activity by 50%
- Provided as solution with low pH (1 to 2+)
- Typical dose rates ~ 3.5 lb Fe/lb sulfide
- Quick reaction times

Iron Salts

ADVANTAGES

- Sulfide specific
- Sulfide fully react (not re-released)

DISADVANTAGES

- Corrosive
- Hazardous materials a concern in neighborhoods
- Adds solids to wastewater
- Darkens wastewater: issue for UV systems
- Residual sulfide 0.1- 0.2 mg/L

Nitrates

Calcium nitrate most common

- Non-hazardous

Prevention mode

- Provides substitute food source for microbes when oxygen depleted
- Typical dose ~ 2.1 gal/lb sulfide

Removal mode

- Nitrate biochemically oxidizes sulfide
- Typical dose ~ 0.7 lb gal/lb sulfide
- Long reaction time needed (1-2 hrs)

Iron Salts

ADVANTAGES

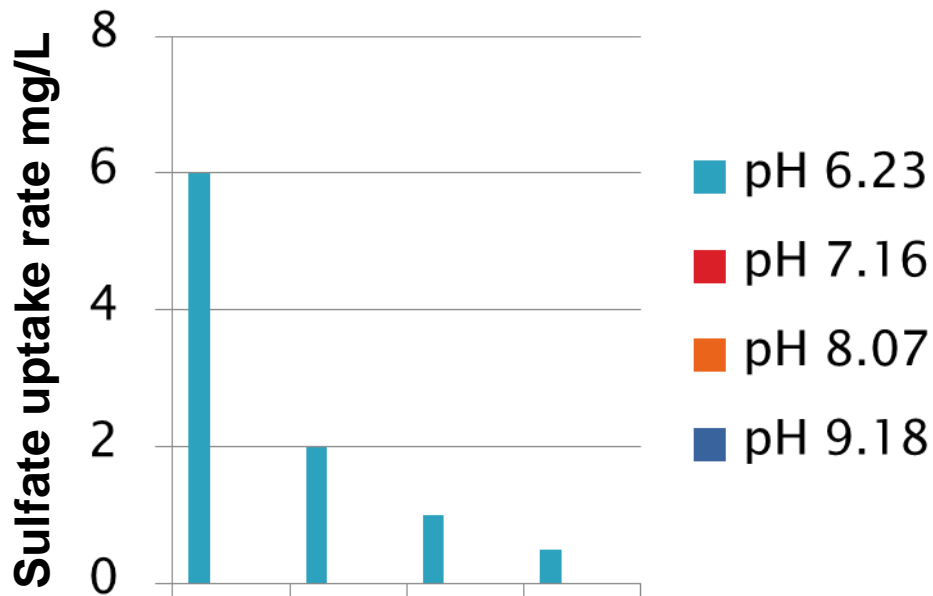
- Non-hazardous chemical
- Provides prevention and treatment
- Reduces sulfide to very low level
- No solids added to system

DISADVANTAGES

- High costs
- Detention time (for removal)
- Some issues with nitrates at WWTP

Magnesium Hydroxide

- Dosing independent of sulfide concentration
- Economical for high (>5 mg/L) sulfide levels
- Maintains pH at 8-8.5, inhibits SRB activity
- Adds alkalinity
- Generally requires mixer to maintain slurry in suspension



Magnesium Hydroxide

ADVANTAGES

- Non-hazardous chemical
- Can provide downstream benefits (alkalinity, etc.)
- Reduces sulfide to very low level
- No solids added to system

DISADVANTAGES

- Holds sulfide in suspension - inflows may reduce pH and release H₂S
- Not generally cost effective for low sulfide streams (under 5 mg/l)
- Mixing required

Important Considerations

Acidic pH = Corrosion!!!

Odor is merely the
symptom.

Corrosion is the real
cancer!

References:

Michigan DEQ - Operator Training and Certification Unit

David Proctor, Chemist and Wastewater Operator

US EPA, Hydrogen Sulfide Control Methodologies

Questions?

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