Internal Corrosion Mitigation Methods

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Appalachian Underground Corrosion Short Course

Internal Corrosion Mitigation Methods

Why mitigate?

“Significant pipeline failures resulting in loss of life and property have caused damages in excess of $7.0 billion in North America since 1995.”

(Source: Pipeline and Hazardous Materials Safety Administration /Energy Information Administration)

Internal Corrosion Mitigation Methods

Why mitigate?

It is the law -

"For onshore transmission pipelines, each operator must develop and implement a monitoring and mitigation program to identify potentially corrosive constituents in the gas being transported and mitigate the corrosive effects."

Source:
DOT 49 CFR 192.478 Internal Corrosion Control: Onshore Transmission Monitoring and Mitigation

Internal Corrosion Mitigation Methods

Internal corrosion monitoring will dictate the best mitigation method based on the quantification and qualification of the corrosive constituents!

Internal Corrosion Mitigation Methods

Common Methods

1) System Design

   A) Water Separators

   B) Pig Launchers / Receivers

   C) Injection Points

   D) Sampling Points

2) Pigging (pipeline cleaning)

Internal Corrosion Mitigation Methods

Common Methods (Cont'd)

3) Siphons

4) Chemical

A) Direct Injection

B) Contact Vessel

a) Liquid

b) Dry Bed

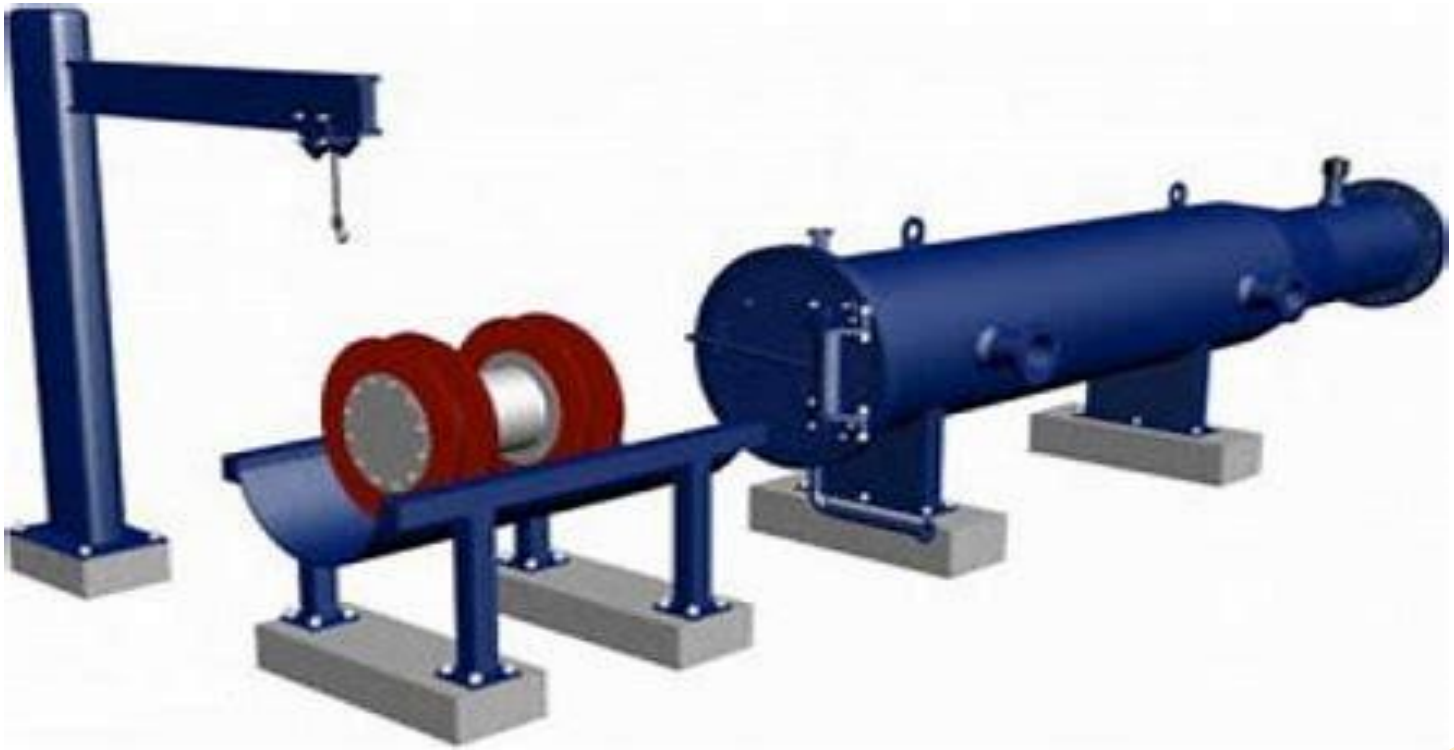
C) Batching with Pigs

Internal Corrosion Mitigation Methods

- System Design
  - Water Separator

Internal Corrosion Mitigation Methods

- System Design (Cont'd)
  - Pig Launchers and Receivers



Internal Corrosion Mitigation Methods

- System Design (Cont'd)
  - Chemical Injection
    - Injection point on long run of straight pipe

Internal Corrosion Mitigation Methods

- System Design (Cont'd)
  - Sample Points

Internal Corrosion Mitigation Methods

- Cleaning (Pigging) Pipelines

The most common method for cleaning pipelines relies on a device (pig) propelled through the pipeline pushing fluids and debris out.

Internal Corrosion Mitigation Methods

- Siphons

  - A method to remove corrosive liquids in gas pipelines under flowing conditions.

  - Used for low areas in the line where a pig cannot clear the liquids.

  - Must reach great depths and usually requires a hot tap to set the access the point.

Internal Corrosion Mitigation Methods

- Chemical

Prior to beginning a chemical mitigation program, the corrosive constituent must be identified and quantified.

- ✓ Hydrogen Sulfide (H_2S)
- ✓ Carbon Dioxide (CO_2)
- ✓ Oxygen (O_2)
- ✓ Chlorides (Cl)
- ✓ Water (H_2O)
- ✓ Biological (SRB / APB)

Internal Corrosion Mitigation Methods

- Chemical (Cont'd)
  - Identifying Corrosive Constituents and Considerations

- Detection Tubes
  - Questionable Accuracy
    - Sample Time and Day
  - Exposure to Poisonous Gases
- Transportable Samples
  - Exposure to Poisonous Gases
  - Transporting

Internal Corrosion Mitigation Methods

- Chemical (Cont'd)
  - Identifying Corrosive Constituents and Considerations

- Portable Analyzers
  - Exposure to Poisonous Gases
- Stationary Analyzers
  - High Cost of Installation

Internal Corrosion Mitigation Methods

Corrosion Mitigation Chemicals

- Corrosion Inhibitors
- Scavengers - H_2S, O_2, CO_2
- Methanol*, Glycol – H_2O (Hydrates)
  * Adds O_2 to the Process
- Biocides – SRB, APB

Internal Corrosion Mitigation Methods

Corrosion Constituent
Hydrogen Sulfide (H2S)

Mitigation Chemicals

- Scavengers (H2S)
  - Triazine
  - Amine (MDEA)

Internal Corrosion Monitoring Methods

Corrosion Constituents
Carbon Dioxide (CO_2)

Mitigation Chemicals

- Scavengers (CO_2 & H_2S)
  - Triazine
  - Amine

Membrane Separators are a common method to remove CO_2

Internal Corrosion Monitoring Methods

Corrosion Constituents
Oxygen (O2)

Mitigation Chemicals
- Scavengers (O2)

Internal Corrosion Mitigation Methods

Corrosion Constituents
Bacteria / MIC (APB)

Mitigation Chemicals – Biocides

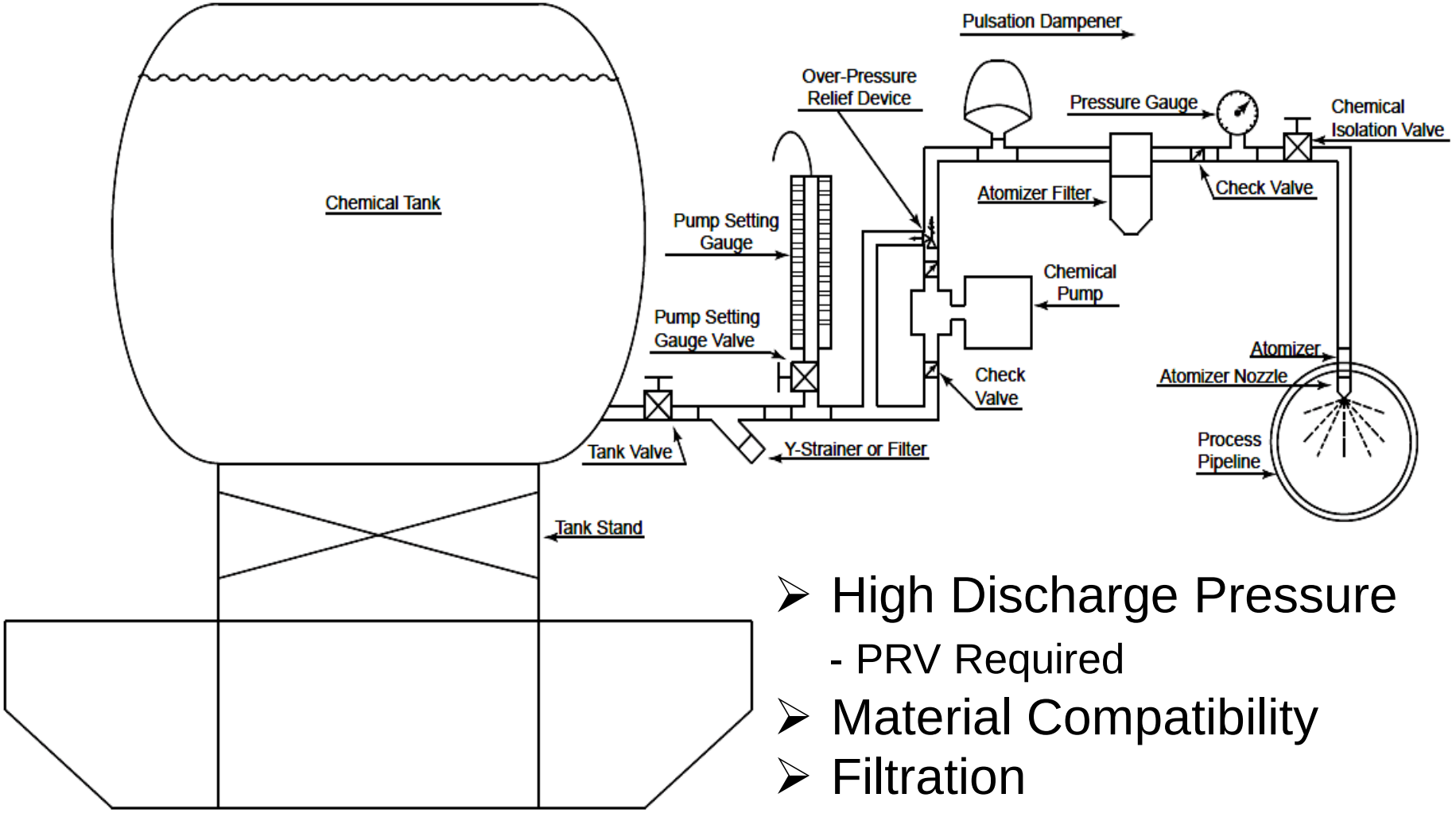
Internal Corrosion Mitigation Methods

Corrosion Constituents
Bacteria / MIC (SRB)

Mitigation Chemicals
- Biocides

Internal Corrosion Mitigation Methods

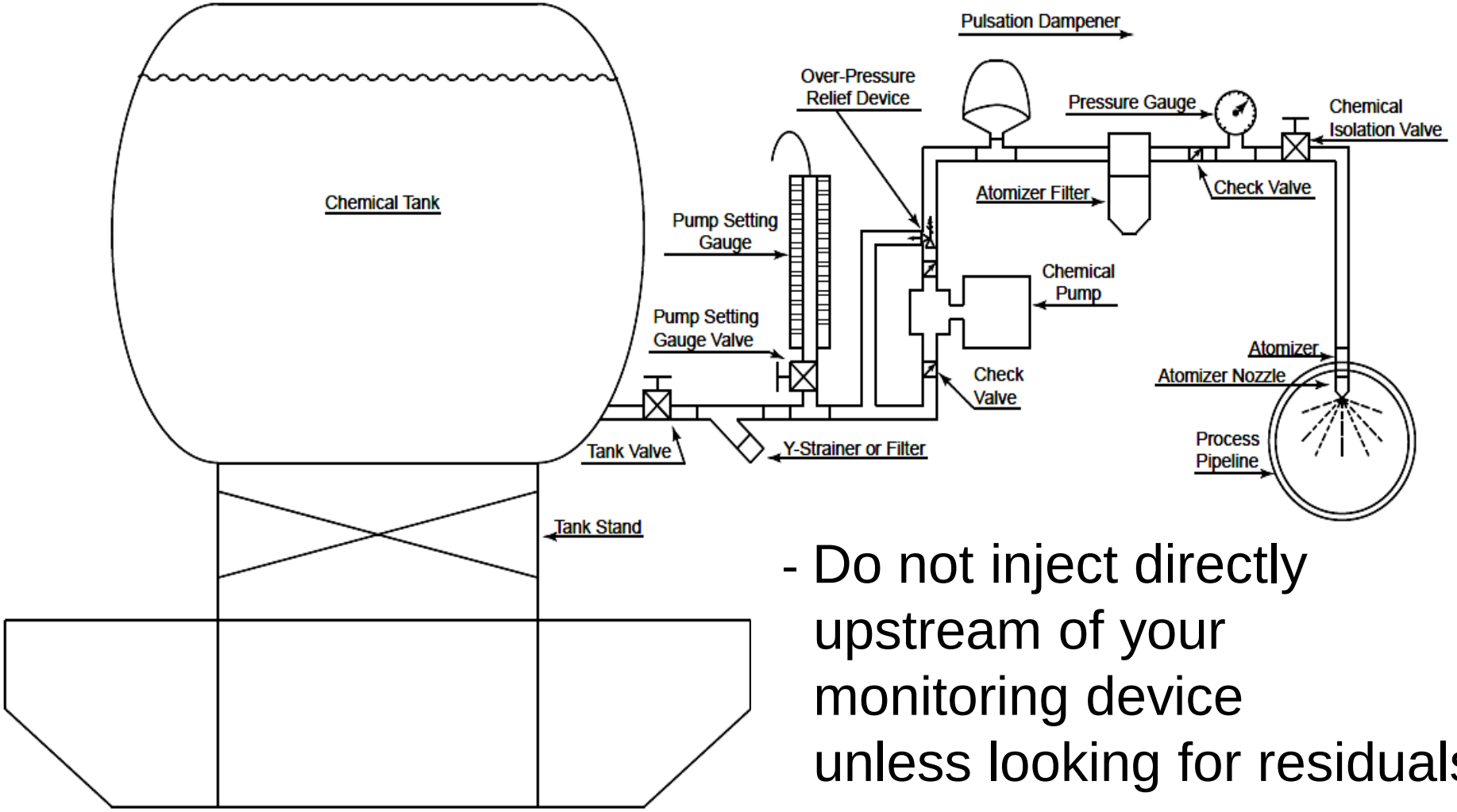
- Chemical - Direct Injection



- High Discharge Pressure
  - PRV Required
- Material Compatibility
- Filtration

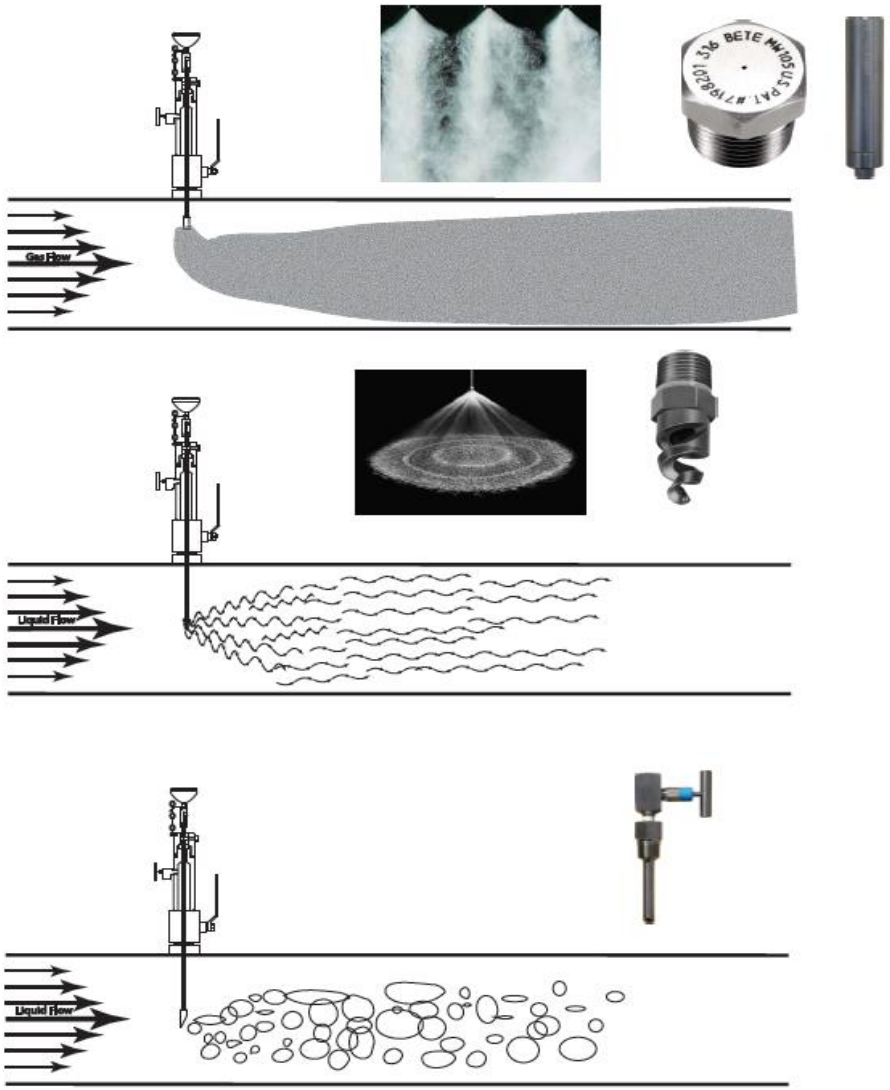
Internal Corrosion Mitigation Methods

- Chemical - Direct Injection (Cont'd)



- Do not inject directly upstream of your monitoring device unless looking for residuals

Internal Corrosion Mitigation Methods



- Chemical - Direct Injection (Cont'd)

Dispersion and Distribution

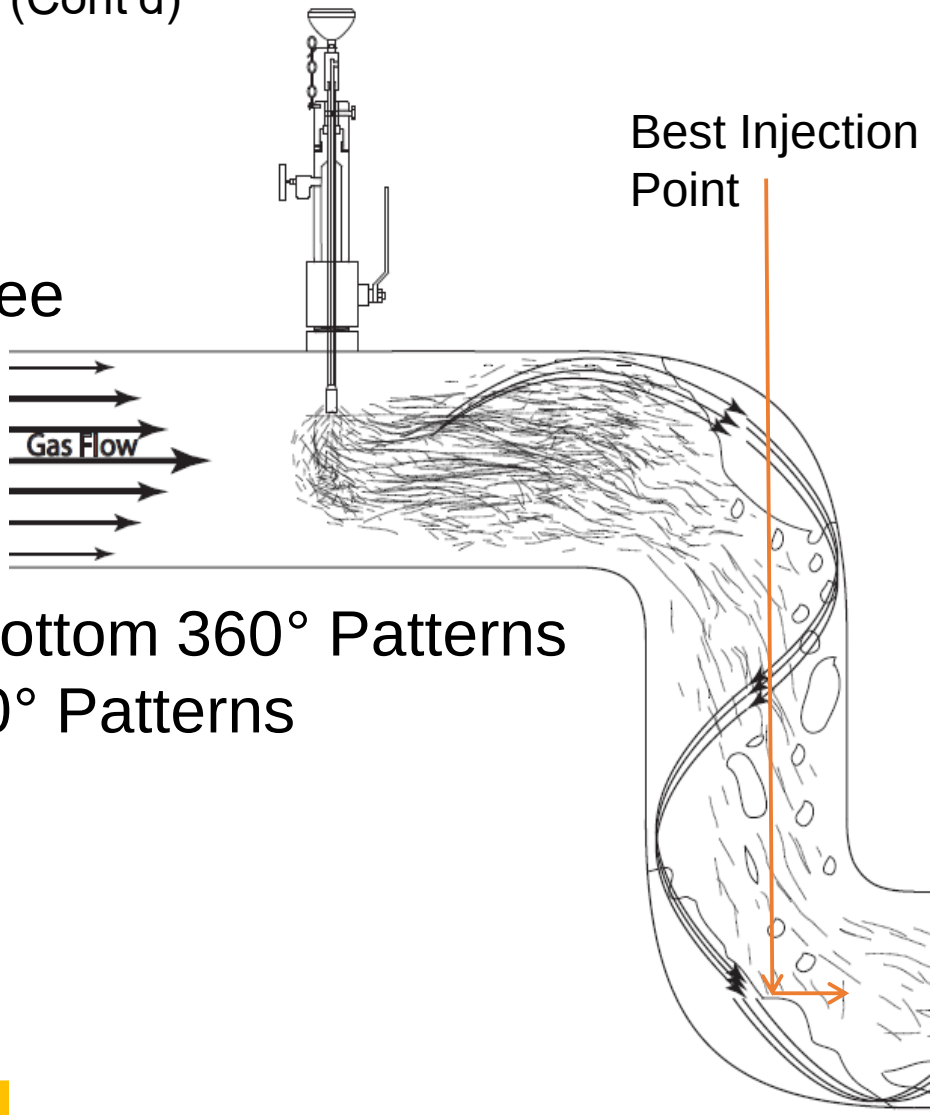
- Atomization
  - Gas Processes
- Mixing Probes
  - Gas Processes
  - Liquid Processes
- Quills
  - Gas Processes
  - Liquid Processes

Internal Corrosion Mitigation Methods

➢ Chemical - Direct Injection (Cont'd)

Dispersion and Distribution

- Injection Device Placement
  - Long, straight, obstruction-free runs of pipe
- Injection Zone
  - Atomizer
    a) Top 1/3 of Process for Bottom 360° Patterns
    b) Center of Process for 90° Patterns
  - Mixing Probes and Quills
    a) Center of the Process



Internal Corrosion Mitigation Methods

Injection atomizers, mixing probes and quills could require maintenance so retractable models should be considered.

Internal Corrosion Mitigation Methods

Proving the chemical mitigation program – Sampling

- Bacteria (SRB)
  - Sulfate Reducing
- Bacteria (APB)
  - Acid Producing
- H2O
- Carbon Dioxide CO_2
- Hydrogen Sulfide H_2S
- Chlorides/Sulfides
- Paraffin
- Iron (Fe) Count
- Corrosion Coupons

Internal Corrosion Mitigation Methods

- Contact Vessel
  - Liquid Chemical Filled
    - Gas Processes
  - Dry Bed Adsorbent
    - Gas Processes
  - Temperature
    - Gas and Liquid Process

Internal Corrosion Mitigation Methods

- Batching Pigs

Utilizes a pig to apply the chemical along the pipe walls

Common Applications:

a) Corrosion Inhibitors

b) Biocides

Internal Corrosion Mitigation Methods

- Considerations

A balanced corrosion mitigation program includes pigging and chemical applications.

1) Intrusive

   a) Chemical injection – limited to process fluid volume and volume of corrosive constituent

   b) Siphons

   c) Batching with a pig

2) Non-Intrusive

   a) Bypass through a contact vessel

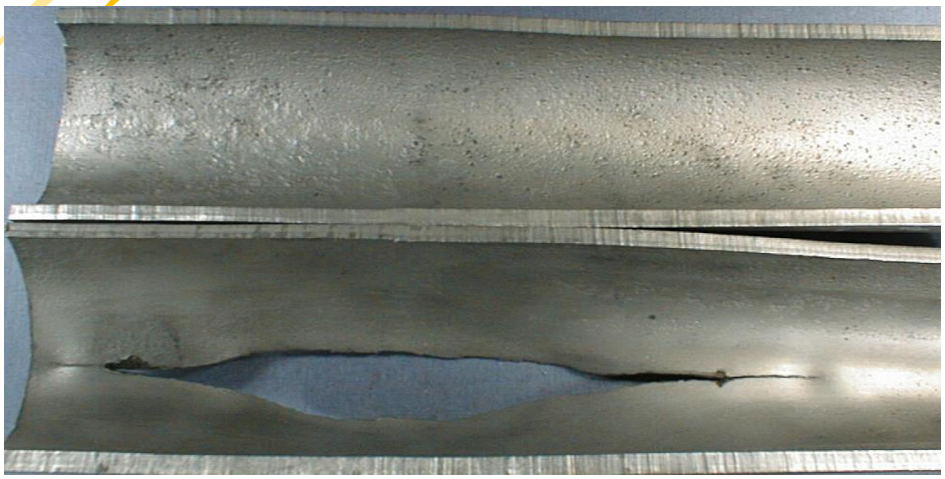
Internal Corrosion Mitigation Methods

- Considerations (Cont'd)

3) Over exposing chemical scavengers to corrosive constituents can create solids.

4) Chemical injection systems and contact vessels can be automated and remotely monitored for optimum performance.

Internal Corrosion Mitigation Methods



You Don’t Need to Mitigate Corrosion on Everything…But You Do Need to Mitigate Corrosion on What You Want to Keep!