Addressing Microbial Issues In Coiled Tubing: We are all in this together…

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OSP

TARGET | TEST | TREAT

MICROBIAL ISSUES IN CT

Thanks for having OSP back!

Previous talks…

- Microbes are a contributing component to corrosion
- Biocide selection process
- Basic onsite programming

MICROBIOLOGICALLY INFLUENCED CORROSION

Update to Stakeholders

Create awareness, foster learning and understanding, and implement action to reduce corrosion related CT failures

- Many if not all CT operators US/Canada are using biocides
- Many CT operators are testing for microbes on site
- OSP is supporting partnerships for evaluating this process with a number of CT operators

PRESENTATION AGENDA

- How does MIC fit into the corrosion equation
- What criteria dictate onsite microbial inhibition programs
- What we can do today
- What is missing
- Summary

Corrosion

The Big Picture

CORROSION

Start with what we know

1. What physical conditions are present?
2. What chemical conditions are present?
3. What corrosion products were formed?
4. How does the material behave in this environment?
5. What are the microbiological characteristics of the biofilm?

CORROSION

Start with what we know

- **Abiotic** (NOT Microbiological) **Corrosion**:
  - CO_2, H_2S, acid or a concentration cell created via any means including mechanical or metallurgical
- **Biotic Corrosion**:
  - Microbiologically INFLUENCED – microbes had an effect on abiotic conditions
  - Microbiologically INDUCED – caused principally by microbes

- MIC can initiate, contribute to or accelerate corrosion that was caused by any mechanisms creating wall loss.

CORROSION

Applying knowledge to CT applications

If microbes are present, control is required regardless if they are the root cause, as they can ultimately contribute to any corrosion mechanism.

SNOW TIRES

Root Cause Analysis:

- Driver Fatigue
- Icy Conditions
- Wildlife on the Road
- Low Sun Impairing Visibility
- Worn Brake Pads

CORROSION

How?

- When and where should biocide be applied?
- Do we always need biocide? What about a corrosion inhibitor?
- How and when do I test with ATP to optimize my chemical usage?
- Which biocide works best?

CORROSION

How?

- Is control required during jobs, or is a clean out sufficient?
- Does recycled water have worse microbes in it?
- Why do I always have more failures in one area, or with one operator?
- How do I know if it was a MIC failure? Process of elimination?

CORROSION

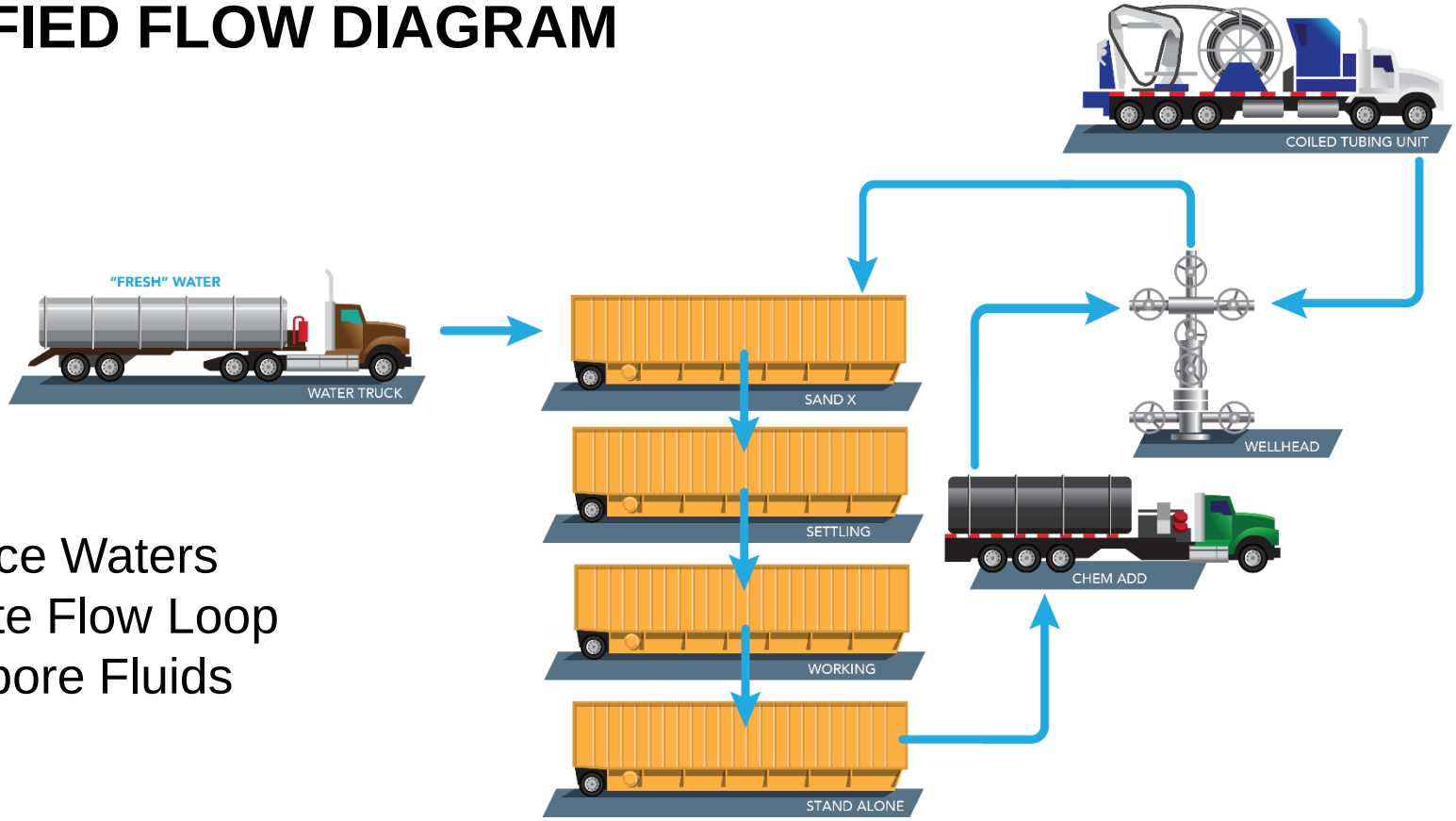
There is no ONE fix, but we can make it easier.

We have been working closest with Permian CT operators. We consider this our *worst case scenario* and subsequent learnings will require tailoring to less challenged applications.

Microbes in CT Operations

Breaking down the system

SIMPLIFIED FLOW DIAGRAM



1. Source Waters
2. Onsite Flow Loop
3. Wellbore Fluids

THE SYSTEM

Source Water

- The **working fluids** – baseline for the whole operation
- Water is added and sometimes removed from the process, but starting with a controlled base fluid is important
- Ensure base fluid is controlled at the start of any job, even when moving from well to well, same location or otherwise → create a starting point to keep fluids in check

THE SYSTEM

Onsite Flow Loop

- This is where the treatment and monitoring are easiest
- Consider a full turnover in a tank as a brand new water
- Contamination, growth, and general microbial stabilization or destabilization can occur depending on rates and system
- The environment on surface is aerobic, ambient, & flowing. Very different from the environment once in the tubing and moving downhole
- This is the most DYNAMIC area of operations

THE SYSTEM

Wellbore Fluids

- Working fluids experience increased temperature and pressure
- Downhole fluids are added to the working fluids, and can contain very high levels of microbes from previous operations i.e. frac fluids
- Biocides can be consumed quickly in this environment meaning reduced chems at surface, and reduced chems available for increased microbial loads

THE SYSTEM

What have we figured out?

- CT jobs are VERY dynamic, and faster paced.
- Getting too detailed onsite with testing and treating in very short time frames is exhausting.
- Ineffective frac biocide programs means increased microbes in CT operations.
- Baseline programs, and fast fixes are both important.

THE SYSTEM

Rules of Thumb to Guide YOUR Program

1. Know your turn-over rate of the surface tanks, and adjust your test and dose frequency accordingly.
2. Spot check regularly but at comfortable frequency.
3. Keep active biocide in your working fluids as an insurance policy for unpredicted down time, and extra fire power.

THE SYSTEM

Rules of Thumb to Guide YOUR Program

4. Be prepared for spikes in microbes, adjust biocide when needed.
5. Dose ALL surface tanks when a spike is discovered.
6. If you add water, add biocide.

Some applications will require less action, some will require focused diligence. Adjust as needed.

What’s still missing?

Working together

FAILURE ANALYSIS

DNA Testing for MIC related Microbes on Failed Pipe

- More pipe samples – collected with appropriate handling & preservation methods
- More context – the end result is a correlation of many jobs and a dynamic pipe life
- Correlation to current methods i.e. pit morphology and sulfur deposits – is there a correlation? Are we drawing the right conclusions? Can it be quantified?

SURFACE SWABS

DNA Testing for MIC Microbes

CT Pipe Sample	ATP	MIC via DNA
CTPB 1802	+ Low	+ SRB Present
CTPB 1812	+ Low	+ SRB Present
CTTO 1813	+ Moderate	+ SRB & Methanogens Present
CTST 1856	+ Low	+ SRB Present
CTST 1870	+ Moderate	+ SRB Present

CLEANOUT EVALUATION

- Currently focused on control during operations
- Gathering info on the different clean out procedures:
  - Wiper balls, brush pigs, and sequencing with chems
  - Biocide Selection
  - Corrosion Inhibitors
- Evaluating a cleanout method with a US CT partner – seeing failure reductions, need to correlate data.

FULL STAKEHOLDER ENGAGEMENT

- Frac Companies – their biocide programs greatly influence fluid control during CT operations
- Producers/Operators – are they aware of the direct impact of completions decisions on mill outs?
- Metallurgists, Manufacturers, Microbiologists & Other Experts?

Summary

SUMMARY

We are all stewards of the health and productivity of the wells we operate on.

OSP Objective today:

- Update on Learnings
- Open Invitation for Collaboration
- Support on Program Development
- Microbial Expertise & Discussion ANYTIME!

WHAT'S STILL MISSING?

It's never one thing…we are all in this together.

THANK YOU

Questions?

Oct 24th 2018