



# Challenges in Microbial Assays of Produced Waters

**L. Keith McLeroy**

Technical Advisor, Pipeline Services Schlumberger

© 2013 Schlumberger. All rights reserved.

An asterisk is used throughout this presentation to denote a mark of Schlumberger. Other company, product, and service names are the properties of their respective owners.

**Schlumberger**

# Introduction

---

## Abstract

Most often oil and gas produced waters are allowed to either accumulate in storage tanks or ponds until further disposed of or treated for reuse.

During this detention time, bacterial growth can occur and proliferate. These bacteria in turn can cause negative effects on treatment and reuse applications.

- This presentation examines the various methodological approaches that are utilized in both field and laboratory analyses for bacteria in oil/gas produced waters and to facilitate discussions among industry leaders.

# Bacteria Concerns in Produced Waters

## Causes

- Are ubiquitous in the environment
- Will be encountered in all aspects of water related processes in oil/gas exploration and production
- Bacteria are present in sands, muds, tankers and piping
- Pre and post production aspects of oil/gas drilling add to the proliferation of bacteria growth
- Bacteria growth alters chemistry

## and

## Affects

- Difficult to keep them under control
- Water sources can be at times, loaded with high concentrations of bacterial growth. i.e.: the source, stagnation and organic concentrations
- Meaning that nothing is ever “disinfected” nor “sterile”
- Activities can add to enhancement of bacterial growth and contamination
- Producers of H<sub>2</sub>S, biofilm, acids and other negative effective compounds

# Bacteria Related Topics

---

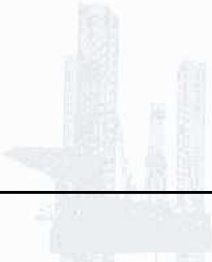
Complexity of Water Matrix

These Matrix Problems Cause Difficulties in Culturing  
Commonly Utilized Assay Methods don't Necessarily  
Work in Produced Waters

There is No Consistency of Bacteria in All the Various  
Produced Waters We See



# Next Day



# “What is the Best Method to Use for Bacterial Monitoring in the Oil & Gas Industry”? Ask First:

---

What Aspect(s) of the Microbial Community is (are) of Concern?

Potential Transport of Opportunistic Bacteria into the Operator’s Water Supply? How?

Formation Sourcing? And MIC? Disinfection Loading?

Others?

Once you know what you need/want to control, then selection of the appropriate method becomes more selective.

# Considerations

---

Sampling (Poor Sampling Will Contribute to Poor Results)

Uneven Bacterial Distribution Throughout a System

Lack of a Background Bacterial Baseline

Organic Loading (FOOD)

Aerobic, Anaerobic or Facultative (as a Biomass)



## Other Considerations

---

An Absolute Understanding of the Microbiological Protocol That You are Employing (What interferences exist for that specific protocol?)

Lack of Using Known Bacteria Cultures (As a Positive Growth Reference)

Thought: Are the results of bacterial testing an absolute or an approximation? And what do you plan to do with the data?

# Produced Water Bacteria 101

---

*Planktonic*- are any organisms that live in the water column and are incapable of swimming against a current

*Sessile*- are organisms associated with biofilm development and corrosion related issues. They are protected in antagonistic environments such as produced waters, by growing as colonies encased in an extracellular matrix of carbohydrates (exopolysaccharide)

# FACTS!

---

According to the NACE International, “attached microbes (sessile bacteria) are normally the most important biological component of the bacterial ecology of an oilfield system”.

Methods utilized for planktonic bacteria are of limited use for assaying sessile species. One must then consider that both of these bacteria will exist in all aspects of water related applications of the oilfield and that they should have protocols listed for assessing both.

# Assaying in Produced Water

---

Sulfate-Reducing Bacteria (SRB)

Iron-Oxidizing Bacteria (IOB)

Heterotrophic Biofilm-Forming Bacteria (HBB)

Acid-Producers (APB)

Others?

## Noted Methods Review

---

American Petroleum Institute Method API RP 38, similar in part to NACE Standard TMO194-94: Field Monitoring of Bacterial Growth in Oilfield Systems. (Commonly called “The Bug-Bottle Method”)

API RP38- MPN Plate Count

HACH® BART-Bottles

Various Present/Absent Bottle Protocols

Others?

# Emerging Technology

---

ELSIA-PCR (polymerase chain reaction) DNA sequencing technique

Enzyme substrate fluorescence technique

Epifluorescence microscopy (acridine orange stain method)

On-line monitoring

Others?

# Starting Techniques and Protocols

---

Sampling

Complete Understanding of Method

Matrix Interferences

Establishing a Biomass Baseline

Selecting the Proper Protocol and Media

The More Advanced Assays Require Additional Steps and Considerations

# Review of Concerns Common in PW Bacterial Assay

---

Chemistry of the PW  
Sampling Locations  
Modifying the Protocol  
False Positives  
Color Changes  
Turbidity/Solids  
Others?



# Complex Issues Related to Advanced Assays

---

Matrix Interferences

Enzymes and Oil Don't Mix

Troubleshooting and Method Modifications

Need a Good Grasp of the Reactions

Use Known Bacteria Strains

# Future Concepts

---

Microbiology Will Need to Be a Focal Point in All Oil/Gas Production Activities

Current Protocols and Revisions

On-Going R&D, Industry & Academia

Instrumentation, Real-Time Monitoring

What Else?

# Thank You!

---



**Keith McLeroy**  
**Technical Advisor**  
**[lmcleroy@slb.com](mailto:lmcleroy@slb.com)**  
**281-921-2934**

**Schlumberger**