RESERVOIR SOURING AND WATER BREAKTHROUGH RSE021

COURSE DESCRIPTION

As reservoirs age and water injection is implemented for pressure maintenance, there is an inherent risk of reservoir souring due to the co-mingling of injection waters and formation waters. Souring occurs as a result of the down hole activity by a specialized group of micro-organisms, the sulphate -reducing bacteria (SRB). The prediction of reservoir souring requires assessment of three key factors: (1) Microbial generation of H2S (2) Transport and scavenging of microbial generated H2S in the reservoir and (3) Partitioning of H2S between the oil, gas and water phases. This course covers all topics related to reservoir souring and water breakthrough.

COURSE GOAL

To enhance participants' knowledge, skills, and abilities necessary to help predict and avoid reservoir souring and its negative consequences.

COURSE OBJECTIVES

By the end of this course, participant will be able to:

- Characterize the causes of reservoir souring.
- Apply reservoir souring remediation methods.
- Understand the modeling process of reservoir souring.
- Understand the framework of the general purpose adaptive simulator (GPAS).
- Implement the biological model in GPAS.
- Identify the effect of dispersion on reservoir souring.
- Apply GPAS reservoir souring model.

WHO SHOULD ATTEND

- Employees new to the E&P business.
- Geologists.
- Drilling and completion engineers.
- Production engineers.
- Government officials.

COURSE DURATION

5 Working Days

COURSE OUTLINES

1. Reservoir Souring

2. Microbial Reservoir Souring
   - Sulfate-Reducing Bacteria
   - Souring Mechanism
   - H2S Transport

3. Reservoir Souring Remediation Methods
   - Sulfate Nano-Filtration
   - Biocides
   - Nitrate Injection
     - Experiments for Reservoir Souring Remediation by Nitrate.
     - Field Application of Nitrate Injection

4. Modeling of Reservoir Souring
   - Mixing Model
   - Biofilm Model
   - Thermal Viability Shell (TVS) Model
   - Mechanistic Model of Burger et al. (2005
   - Reservoir Souring Simulators
   - Reservoir Souring Simulation with UTCHEM

5. General Purpose Adaptive Simulator (GPAS)
   - Overview of GPAS
   - Framework
   - EOS Compositional Module
   - Chemical Compositional Module
     - Governing Equations
       - Material Balance Equations
       - Volume Constraint Equation
       - Fully-Implicit Solution Procedure
   - Corner Point Formulation
   - Parallel Processing

6. Implementation of the Biological Model in GPAS
    - Overview of Biological Model
        - Product Generation, Nutrition, and Inhibition Effects
        - Solving the Biological Model Equations
    - Modeling Nitrate Inhibition Mechanisms
        - Inhibitory Action of Nitrite
        - Bio-Competitive Exclusion
        - Nitrate Utilization by SRB
        - Nitrate-Reducing Sulfide-Oxidizing Bacteria Stimulation
    - Implementation in GPAS
        - Solution of the Combined Transport and Biological Equations.
        - GPAS Biological Model Code

7. Model Verification with Experimental Data
    - Microbial Souring in Porous Media
    - Control of Microbial Souring by Nitrate
    - NR-SOB Activity in a Batch Reactor
    - NR-SOB Activity in a Column

8. Effect of Dispersion on Reservoir Souring
    - Dispersion in Porous Media
        - Molecular Diffusion and Mechanical Dispersion
        - Convection Diffusion Equation (CDE)
    - Investigation of Dispersion Effects by UTCHEM
        - One-Dimensional Homogeneous Reservoir
        - Three-Dimensional Heterogeneous Reservoir Model
            - Seawater Injection (SWI)
            - Produced Water Re-Injection (PWRI)
            - Effect of Heterogeneity

9. Physical Dispersion Model in GPAS
    - Full Tensor Formulation in GPAS
    - Semi-Implicit Implementation
    - Physical Dispersion Model Verification
        - Validation with One-Dimensional Analytical Solution
        - Comparison of Two-Dimensional Simulations with UTCHEM .

- Non-Orthogonal Grid

- Investigation of Numerical Dispersion in GPAS
  - Truncation Error Analysis
  - Gridblock Size Effect
  - Time Step Effect

10. **Field Application of GPAS Reservoir Souring Model**

- Non-Orthogonal Reservoir Model
  - Souring without Nitrate Injection
  - Nitrate Injection after H2S Breakthrough
  - Initial Nitrate Injection
- Parallel Processing
  - Model
  - Multi-Processor Runs
  - Grid Refinement