CO$_2$ Corrosion and Inhibition
Current Status and Future R&D

by

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CO₂ Corrosion – Current Status

- Relatively well understood ... An old enemy/friend
- Abundance of field data ... mostly inhibited systems
- Failures due to CO₂ corrosion are and remain reel ... mainly in combination with other issues
- Has been modeled over the years by virtually all the experts in the matter, in different but comparable ways:
  - simple to sophisticated models
  - empirical vs mechanistic models
  - accuracy and validity boundaries
- Tremendous amount of literature

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CO₂ Corrosion – Remaining Uncertainties

R&D topics

✓ Understanding pitting initiation and propagation processes
✓ FeCO₃ film stability/properties
✓ Synergy with H₂S corrosion
✓ Predictions at high T&P
✓ Presence of oil
✓ Complicated flow regimes
✓ Effect of brine chemistry (e.g. organic acid)

Prediction of pitting corrosion – statistical tools
✓ Blend of empirical/mechanistic models
✓ Synergy between FeS/FeCO₃

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CO₂ Corrosion Inhibition – Current Status

✓ Use of corrosion inhibitors ... popular practice in operations

✓ Corrosion inhibitor chemistry ... varies but remains abundant and competitive among vendors

✓ Inhibitor selection and performance testing for a given application ... remains an important issue, controversial at times

✓ Injection mode, injection rate ... application specific

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CO₂ Corrosion Inhibition Challenges

- Protection at high T&P
- Effect of complicated flow regimes
- Partitioning of inhibitor between oil and water phases
- Performance in presence of solids
- Compatibility with other chemicals
- Protection of TOL
- QC management
- Monitoring (e.g. residual analysis)
**CO$_2$ Corrosion Inhibition**
**R&D topics**

- Chemistries for high temperature applications
- Greener products
- Vapor phase inhibitors
- Effective inhibitors in sour conditions
- Compatibility with KHI and biocide
- Standard methods to test inhibitor performance
Corrosion Inhibitor Testing Program
How and What to test for

- Simulate field conditions (chemistry, T, P, flow regime, shear levels, solids, other chemicals injected)
- Utilize a variety of experiments to predict inhibitor performance (bubble, BTA, RCE, RCA, J1L, flow loops)
- Assess both general and localized corrosion
- Judge performance on weighted importance of parameters and interactions
- Accommodate for varying operating conditions (account for MOC)
- Test best performers in field trials (if possible)
- Provide reproducible data
Detailed slides
TD/Research Action Items

Simulate field conditions (chemistry, T, P, flow, solids)

- Choose an optimum set of operating conditions
- Design experiments to simulate flow conditions
- Identify type of solids to consider and means to account for and evaluate impact on inhibitor performance
TD/Research Action Items

Utilize a variety of methods to predict inhibitor performance

- Prioritize experiments for a given production environment
- Utilize different methods of measuring the corrosion rate
- Formulate a global decision process for inhibitor selection
TD/Research Action Items

- Assess both general and localized corrosion

- Design experiments to evaluate localized corrosion

- Identify a quantifiable mean to measure localized corrosion

- Decide how to account for the relative importance of uniform corrosion rates and localized attack data
TD/Research Action Items

Account for all important performance parameters and interactions

- Inventory all important parameters affecting inhibitor performance for a given production

- Assess the application of experimental design to:
  - minimize the experimental work,
  - facilitate the interpretation of the results
  - formulate a prediction model for slightly different conditions
  - Identify the interactions between the studied parameters

- Identify key parameters for given production conditions

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TD/Research Action Items

Accommodate for the life cycle range of operating conditions

- Implement a statistical analysis of the collected data
- Perform a sensitivity analysis for the main parameters
- Provide a dose dependent performance of the top ranked inhibitors
TD/Research Action Items

- Differentiate between good and excellent inhibitors
- Identify the inhibitor dosage to be used for qualification
- Set up threshold values for general corrosion to identify bad inhibitors
- Design a criteria to identify the best inhibitors
- Combine data from different experiments to validate the performance of excellent inhibitors
- Consider environmental constraints
TD/Research Action Items

- Rank inhibitors based on field related factors

- Identify field parameters affecting inhibitor performance

- Use the identified parameters to assess the performance consistency of top ranked inhibitors

- Identify the optimum inhibitor dosage within the range of the chosen key parameters
TD/Research Action Items

- Provide reproducible data

- Perform experimental sensitivity analysis for the main operating parameters

- Set up the accuracy range of the measured corrosion rate for each experiment used within the testing program

- Implement the use of standard deviation and confidence interval values