USING OLI TO MANAGE PRODUCTION WELLS

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Outline

- Use of OLI to Manage Production Wells
- Artificial Lift Methods – Production Chemistry Issues
- Case Study – ESP Scaling
- Conclusions
Use of OLI to Manage Production Wells

- OLI corrosion and scale modeling capabilities are extensively used to manage production wells during their lifecycles including:
  - Formation water formulation, QA/QC
  - Designing of drilling/completion fluids
  - Casing and tubing design
  - Flowback management
  - Choke/wellhead pressure management
  - Designing corrosion and scale treatment programs
  - Predicting artificial lift method issues
Artificial Lift Methods - Prod. Chem Issues

- Plunger Lift – corrosion/mechanical damage, solids drop-out
- ESP – Scale/salt drop out, asphaltenes, corrosion
- Rod Pumping - Corrosion
- Hydraulic Piston/Jet – Scale
- Gas Lift – Inorganic/organic solids, hydrates
- Progressive Cavity – Erosion/corrosion, material incompatibility
ESP Case Study
ESP Scale Analysis—Background

- ESP failed within a short time
- Solids captured from the ESP showed:
  - 32% CaSO4
  - 26% CaCO3
  - 7% NaCl
  - 4% SrSO4
  - 5% Others
  - 26% organics

QUESTION: Source(s) of scales (formation and/or kill fluid) and at what conditions
ESP Scale Analysis – Conditions & Fluids

- Tight gas sand reservoir with about 10% carbonate
- BHT = 160-165°F
- BHP > 4000 psia
- Production rates:
  - 300 bwpd
  - 150 bopd
  - 0.9 MMcf/d gas
  - CO2<0.1%
- Formation water and Kill fluid compositions

<table>
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<tr>
<th>ELEMENTS</th>
<th>CONCENTRATION, mg/l</th>
<th>Formation Water</th>
<th>Kill Fluid</th>
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<tr>
<td>Barium</td>
<td>Ba^{2+}</td>
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<td>Calcium</td>
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<td>Iron</td>
<td>Fe^{2+} or Fe^{3+}</td>
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<td>pH</td>
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ESP Scale Analysis (Cont)
Pressure & Temperature Profiles

» Pre ESP: \( T = 161 \degree F \) & \( P = 4039 \text{ psia} \)
» With ESP: \( T = 176 \degree F \) & \( P = 1735 \text{ psia} \)
ESP Scale Analysis (Cont)
Cases and Conditions Examined

❖ Scale prediction modeling with following fluids
  • Total well stream alone in production mode
  • Kill Fluid injection – mixes with reservoir fluid
  • Kill Fluid in reservoir both fresh and contacted with reservoir rock (dissolves carbonates, pH increases)
  • Kill Fluid flowback alone
  • Kill Fluid production followed by reservoir stream

❖ Conditions
  • Pre ESP: $T = 161 \, ^{\circ}F \, & \, P = 4039 \, \text{psia}$
  • With ESP: $T = 176 \, ^{\circ}F \, & \, P = 1735 \, \text{psia}$

❖ Also Examined
  • Temperature range: 100 - 225 $^{\circ}F$
  • Pressure range : 100 – 5000 psia
ESP Scale Analysis – Key Results

Production of Well Stream – Sensitivity to Temp @ Pre and ESP Press

Total Solids & Calcite Scales for Daily Well Stream - Pre ESP and ESP Operating Conditions
ESP Scale Analysis – Key Results
Production of Well Stream

Total Solids & Potential Scales Pre ESP and @ ESP Operating Conditions
ESP Scale Analysis – Key Results
Production of Kill Fluid & Well Stream – Sensitivity to Blends & Temp @ ESP Pres
ESP Scale Analysis – Key Results

Production of Kill Fluid & Well Stream - Sensitivity to Fixed Blends & Temp @ Pre & ESP Pres
Scales obtained from ESP were likely to be caused upon mixing of formation brine with Kill Fluid at ratio of 0.8 to 0.9 (formation brine/Kill Fluid) at inlet temperature range of 180 °F- 200 °F.
ESP Recommended Working Conditions

Graph showing the relationship between pressure (psia) and temperature (F) for different flow rates and gas production. The graph indicates recommended working conditions for 338 Mcfd gas, 152 bwpd, and 60 bopd.
ESP Scale Analysis – Summary

- Calculations show that scales are likely to form at ESP inlet caused by both decreasing pressure and increasing temperature.

- Compositions and quantity of scales are controlled by not only formation water but also Kill Fluid, formation rock and hydrocarbon compositions.

- Scales obtained from ESP were likely to be caused upon mixing of formation brine with Kill Fluid at ratio of 0.8 to 0.9 (formation brine/Kill Fluid) at inlet temperature range of 180°F - 200°F.

- Kill Fluid should have sufficient scale inhibitor to prevent incompatibility with formation brine; pH adjustment to have no self scaling may not be sufficient.

- Detailed evaluation of all potential production conditions under realistic conditions is essential to understand potential solids deposition in ESP lift systems, preventive measures such as scale inhibitor injection should be implemented.
In artificial lift selection process, corrosion and production chemistry issues are generally overlooked.

Critical evaluation of all aspects of artificial lift methods is essential for their successful implementation in fields. Proper use of modeling tools can help to avoid failures.

Many of the artificial lift methods can cause scaling/salting conditions, however preventive measures are readily available and must be employed.

Preventive measures include proper formulation of Kill Fluids, batch or continuous scale inhibitor and/or dilution water injection.

Corrosion failures in plunger lift wells generally occur near joints due to continuous removal of protective passive layer. Focus should be on better design of joints.

Corrosion rates in plunger operated wells can be higher but overall yearly rate could be lower if removal of the protective deposits/scales can be prevented.
QUESTIONS/COMMENTS
ESP Scale Analysis – Key Results
Production of Well Stream

Total Solids & Calcite Scales Per 1 bbl of Well Stream - Pre ESP and ESP Operating Conditions