Primary funding is provided by

The SPE Foundation through member donations and a contribution from Offshore Europe

The Society is grateful to those companies that allow their professionals to serve as lecturers

Additional support provided by AIME
A HOLISTIC APPROACH TO UNDERSTANDING THE IMPACT AND CAUSE OF FINES PRODUCTION

David Underdown
Chevron Energy Technology Company
AGENDA

• The consequences of fines production
• Sources of fines
• Dealing with fines
• Lessons Learned & Best Practices
FACILITIES

DRILLING & COMPLETIONS

OPERATIONS

FINE PRODUCTION

FLOW ASSURANCE
CONSEQUENCES OF FINES
PRODUCTION
FINES PRODUCTION CAN BE A BIG PROBLEM!!
FINES PRODUCTION CAN BE A **REAL BIG PROBLEM !!**
SKIN PROGRESSION WITH TIME

![Graph showing skin progression with time for different wells. Each well is represented by a different line, color-coded to indicate their WC levels: Well 1 (16% WC), Well 2 (0% WC), Well 3 (0% WC), Well 4 (19% WC), Well 5 (28% WC), Well 6 (0% WC), Well 7 (16% WC), Well 8 (0% WC), Well 9 (0% WC), and Well 10 (30% WC). The graph indicates a rise in skin with production time, with well 9 showing a significant rise.]
SOLIDS PRODUCTION POSSIBLE
CULPRIT

Production time = 28 months
CONSEQUENCE ON WATER INJECTION

Bottom-Hole Pressure (psi), Total Suspended Solids (mg/lt) = 5
Bottom-Hole Pressure (psi), Total Suspended Solids (mg/lt) = 25
Bottom-Hole Pressure (psi), Total Suspended Solids (mg/lt) = 50

50 kbpd – 250 mD
SAND DEPOSITION IN FLOWLINES

- Pressure losses due to reduced flow area
- Pigging requirement to remove sand
- Under sand bed corrosion
  - pitting

Moving or stationary sand bed
SOURCES OF FINES
SINGLE PHASE CORE FLOW TESTS

\[ k/k_{\text{initial}} = 52\% \] at 30,000 PV

\[ K_{\text{air}} = 283 \text{ md} \]

PLUGGING FINES
MECHANICAL PROPPANT DEGRADATION

Causes
- Stress cycling (during production; shut-in/startup cycling)
- Proppant strength loss during ageing at BH conditions
- Insufficient strength-proppant

Impact on Production
- Fines (crushed proppant) may plug fracture, screen
- Loss of Fracture Width
- Loss of conductivity
FINES FROM STRESS CYCLING ON PROPPANT

SPE 90562
PLUGGED AND/OR COLLAPSED PERFORATIONS

**Cause**
- Extreme dynamic underbalance

**Impact on Production**
- Harder to initiate frac
- Off plane perforations contribute little or none
EFFECT OF SOLIDS ON SCREEN EROSION
FLUX MANAGEMENT – SCREEN EROSION

Causes
- Fines produced through pack
- Voids in pack
- High flow rates

Impact on Production
- Curtailed production
- Cut out screens
- Solids in wellbore and facilities
BRINGING IT ALL TOGETHER

Lean Sigma

- Production Match & Forecast
- Proppant/Formation Fines Generation
- Fines from Formation
- Conductivity Loss from Embedment
- Flux Management
- Proppant Degradation Stress Cycling
- Perforation Optimization
- Fines from Near Wellbore Stresses
- Proppant Diagenesis
DEALING WITH FINES
ORGANIC POLYMER STABILIZATION
ORGANIC POLYMER STABILIZATION
INORGANIC POLYMER STABILIZATION

Sand grain ------- covalent binding ------- sand grain
INORGANIC POLYMER STABILIZATION
COLLABORATION

Completion-types...
What do you mean the well is having production issues, what did y'all do to it now!!

Operation-types...
No we didn't ramp the well up too fast but we have production targets that must be met!

Geologist-types...
I give you the perfect rock and darn if y'all don't mess it up!
LESSONS LEARNED & BEST PRACTICES
LESSONS LEARNED & BEST PRACTICES

- FINES CAN CONTRIBUTE SIGNIFICANTLY TO INCREASING SKINS OVER TIME
- A DEDICATED MULTI-DISCIPLINED / CROSS FUNCTIONAL TEAM IS NECESSARY TO ADDRESS THE COMPLEX ISSUES ASSOCIATED WITH FINES PRODUCTION
- THERE ARE MULTIPLE POTENTIAL SOURCES OF FINES WITH NO ONE APPARENT MAJOR CONTRIBUTING FACTOR
- THE USE OF LEAN SIGMA METHODOLOGY IS A VERY EFFECTIVE WAY TO UNDERSTAND THE IMPACT OF THE MULTIPLE SOURCES OF FINES PRODUCTION
LESSONS LEARNED & BEST PRACTICES

- SOME CONSEQUENCES OF FINES PRODUCTION ARE NOT SO OBVIOUS
  - SAND BED CORROSION
  - SAND CONTROL DESIGN FOR WATER INJECTORS

- NEW APPROACHES TO FINES STABILIZATION INCLUDE
  - INORGANIC POLYMERS – ORGANOSILANES (SPE 95723, 98333)
  - ORGANIC POLYMERS – VAN der WAAL FORCES (SPE 97659)

- THERE IS A GREAT NEED FOR GOOD SOLIDS SAMPLING TECHNIQUES
Your Feedback is Important

Enter your section in the DL Evaluation Contest by completing the evaluation form for this presentation:

Click on:  Section Evaluation