DEA 13 - Revisited

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Fundamental Question - Is the fracture initiation pressure different for water and oil base fluids?
- Answer - No, but the propagation pressure (extension) is lower for oil base fluids.

Result – More difficult to stop lost circulation with oil base fluid.
- Fracture tip screen-out (prevent pressure transmission to the fracture tip) is the assumed mechanism.

Strategy – Prevention is better than remediation
DEA 13 Lost Circulation Studies

• JIP conducted at Drilling Research Labs in mid-80’s
• Organized by Conoco & Tenneco
  – 13-17 participants in Phase I and II
  – Coordinators: Don Whitfill (Conoco) and Weldon Nance (Tenneco)
• Representatives still active in the industry:
  – Conoco Phillips
    • Dave Beardmore
    • Giin-Fa Fuh
    • Ernest Onyia
  – Nobuo Morita – Waseda University, Tokyo
  – Weldon Nance – Hess
  – Joe Billingsley - Oxy
  – Don Whitfill – Halliburton.

Large Sample - 30-in cube

High Cost - $25-30 K/test
DEA 13 Lost Circulation Studies

- Large sample size (1.5-in bore hole in a 30-in cube)
- Fractures could be initiated and then stopped - then reopened and the fracture extended
- “High cost” - $25-30,000 per test at that time.
DEA 13 - Observations

- Fracture Initiation Pressures were not different for oil and water base muds.

- Fracture Propagation (extension) Pressures were lower (easier to propagate) for high density oil base muds than for high density water base muds.
DEA 13 - Observations

- Fracture healing was more significant in water base mud induced fractures than those created with an oil base mud.
- High density oil mud has a lower reopening and propagation pressure than a high density water base mud.
- Relaxed filtrate OBM behavior fell in between WBM and standard OBM.
DEA 13 - Conclusions

- High fluid loss water base systems “healed” fractures more effectively in permeable formations.
- Fracture tip “screen-out” is assumed to be the healing mechanism.
- Calcium carbonate was effective in plugging lost circulation fractures while flake LCM (probably Mica?) was not.
DEA 13 - Developments

- Fibers were not tested and “graphite” LCM materials were not available at that time.

- Conoco Stop Frac, ground petroleum coke, was developed based on this project, and was successfully used in the field.
Publications from/after DEA 13 SPE Literature Only

- **1990** Theory of Lost Circulation Pressure
  - SPE 20409; Morita and Fuh (Conoco) and Black (Drilling Research Lab).

- **1991** An Analysis of Experimental Data on Lost Circulation Problems While Drilling with Oil Base Mud
  - SPE 22581; Onyia, Ernest (AMOCO)

- **1992** A New Approach to Preventing Lost Circulation While Drilling
  - SPE 24599; Fuh et.al. (Conoco)
  - Pretreatment and wellbore strengthening
Wellbore strengthening concepts were “rediscovered” in the 2000’s

- **2001** Fracture Gradients in Depleted Reservoirs
  - Drilling Wells in Late Reservoir Life
    - SPE/IADC 67749; Alberty and McLain (BP)
- **2001** Formation Pressure Integrity Treatments
  - Optimize Drilling and Completion of HTHP Production Hole Sections
    - SPE 68946; Sweatman, et. al. (Halliburton)
- **2004** Drilling Fluids for Wellbore Strengthening
  - SPE/IADC 92192; Aston and Alberty (BP)
- **2004** A Physical Model for Stress Cages
  - SPE 92192; Alberty and McLean (BP)
Wellbore strengthening concepts merged with lost circulation mitigation

• **2005** Fracture Closure Stress and Lost Returns Practices
  – SPE/IADC 92192; Dupriest (ExxonMobil)

• **2005** The Key to Successfully Applying Today’s Lost Circulation Solutions
  – SPE 95895; Wang, et. al. (Halliburton)

• **2006** Preventing Mud Losses by Wellbore Strengthening
  – SPE 101593; Song & Rojas (Halliburton and BP)

• **2006** New Design Models and Materials Provide Engineered Solutions to Lost Circulation
  – SPE 101693; Whitfill, et. al. (Halliburton)
And – The Beat Goes On!

• **2007** Fractured Wellbore Stress Analysis; Sealing Cracks to Strengthen a Wellbore
  – SPE 104947; Wang, et. al. (Halliburton)

• **2007** Further Development, Field Testing, and Application of the Wellbore Strengthening Technique for Drilling Operations
  – SPE 105809; Fuh, Beardmore, Morita (Conoco Phillips, Waseda University)

• **2007** A New Treatment for Wellbore Strengthening in Shale
  – SPE 110713; Aston, et. al. (BP)
-And On!

@2008 SPE/IADC Drilling Conference, Orlando

• Particulate-Based Loss-Prevention Material - The Secrets of Fracture Sealing Revealed!
  • SPE/IADC 112595; Kaageson-Loe, et. al. (M-I SWACO); Taugbøl, et. al. (StatoilHydro ASA).

• Investigation of Factors for Strengthening a Wellbore by Propping Fractures
  • SPE/IADC 112629; Wang, et. al. (Halliburton)

• Method to Eliminate Lost Returns and Build Integrity Continuously with High-Filtration-Rate Fluid
  • SPE/IADC 112656; DuPriest, et. al. (ExxonMobil)
• Terra Tek still available with updated equipment
• Prices have gone up!
• Very Ball Park Estimates are 80-100K per test.
• 15-20 tests may require 1.5-2 MM $
  – This amount (or more) spent on a single lost circulation incident in deep water.
Next Steps

• If interested in further discussion contact:
  – Dave Beardmore (281-293-3967)
  – dave.beardmore@conocophillips.com
  – Don Whitfill (281-871-6042)
  – don.whitfill@halliburton.com

• If 10 companies are interested in following up, a meeting will be held in January
  – No obligation if attending a follow-up discussion meeting
  – Anticipated minimum fee to fund a JIP is $100,000 per participant.

• If continued; Draft Proposal presented at 1Q2009 DEA Meeting with goal of 15-20 participants

• Anticipated start date late 2009 or early 2010.
More Information

• Lost Circulation – Wellbore Strengthening or Remediation – or Both?
  – A proposal submitted to the Society of Petroleum Engineers to place this topic in the 2010 Forum Series.
  – A SPE Forum on Lost Circulation has never been held.
  – Decision to be made in December, 2008.