Enhanced Oil Recovery Institute

Tensleep Reservoir Workshop Update
&
Lab Development

Sheena Xie
Steering Committee

- Allen Brummert, Petroleum Engineer, *Marathon Oil Company*
- Bob Christofferson, Petroleum Engineer, *Citation Oil Company*
- Tom Anderson, Geologist, *Gas Venture*
- Tom Faulkner, Petroleum Engineer, *Breitburn Operating LP*
- Tom Fitzsimmons, Business Unit Leader, *Legacy Reserves Operating LP*
- Brad Bauer, Petroleum Engineer, *Merit Energy Company*
- Chuck Peterson, Petroleum Engineer, *Devon Energy*
Workshop 1: Introduction to Waterflooding in Tensleep Reservoirs
Cody, Wyoming     June 5-6, 2012

Day 1

• Introduction & Overview of Tensleep Reservoirs in Wyoming (David Mohrbacher)
• Reservoir Characteristics (Peigui Yin)
• Bairoil Case Study (Brad Bauer)
• Waterflooding Material Balance (Brian Towler)
• Introduction to Waterflooding Fundamentals in Wyoming Reservoirs (Paul Willhite)

Day 2

• Water management (Brian Towler)
• Laboratory Studies and Wettability (Sheena Xie)
• Conformance Improvement (Reza Barati)
• Operators Case Studies
  - Pitchfork Field Tensleep Waterflood Development (Mike Ramseier, Stephen Schneider, John Deng, Marathon Oil Company)
  - Application of Polymer for Reduced Water Production at Fourbear Field (Chad Forsman, Legacy Reserves Operating)
Presented Field Cases

- **Geological Characterization:** Bighorn Basin Wide Tensleep Reservoirs
- **Material Balance:** Torchlight
- **Fundamentals in Wyoming Reservoirs:**
  - Torchlight, Wertz, Lost Soldier, Hamilton Dome, Oregon Basin
- **Bairoil Complex Overview:** Lost Soldier, Wertz
- **Wettability:**
  - Frannie, Hamilton Dome, Hatfield, Little Buffalo Basin, Teapot Dome, Torchlight
- **Conformance:** Little Buffalo Basin, Lost Soldier, Wertz
- **Operators Case Studies:**
  - Pitchfork (Reservoir characterization, waterflooding, geophysics)
  - Fourbear (Polymer for reduction of water production)
Participated Companies & Individuals

- Breitburn Operating LP
- Devon Energy Corporation
- JJ Bunkirt Oil and Gas
- Legacy Reserves Operating LP
- Marathon Oil Company
- Merit Energy Company
- Wold Oil Properties, Inc.
- Polymer Services, LLP

- Geologist: 4
- Geophysicist: 2
- Engineers: 9
- Technical Manager: 2
- Business Manager: 1
Feedback from Participants

- Topics are appropriate and much has been learnt;
- More case studies on conformance work;
- Sharing business cards within the workshop;
- Add round table discussion and work-out problems;
- All participants expressed interest in EOR workshop (Workshop 2);
- Most participants expressed interest in CO2-ROZ workshop (Workshop 3);
- Key issues identified:
  - Excessive water production & water management
  - Conformance improvement
Other topics should be covered in the workshop:

- More specifics on Tensleep reservoir characteristics;
- Geophysics;
- Polymer flooding;
- Gel for production water control;
- Workovers and recompletions;
- Drilling basics;
- Water management on the surface/discharge;
- Regulatory and operation cost;
- Waterflood pattern design – line drive/5-spot;
- Horizontal drilling in Tensleep reservoirs
Workshop 2: Introduction to EOR in Tensleep Reservoirs
Cody, Wyoming  October 2012

Day 1

• EORI Capability and Introduction to Workshop Two (David Mohrbacher)
• Tensleep Reservoir Geological Characterization, Lithology and Mineralogy (Peigui Yin)
• Fundamentals of EOR Methods (Vladimir Alvarado)
• Polymer Flooding and Sweep Improvement (Guest speaker: Randy Seright)

Day 2

• Tensleep Reservoir Wettability and Feasible EOR Methods (Norman Morrow)
• Gel Conformance Control and Water Shutoff (Guest speaker: Randy Seright)
• Evaluation of CO₂-EOR Options for Tensleep Reservoirs (Shaochang Wo)
• Summary of Wyoming CO₂ & CH₄ EOR (Glen Murrell)
• Field Cases (Operators)
Workshop 3: CO2-EOR in the Bighorn Basin
Cody, Wyoming, Spring 2013

• EORI Capability and Introduction to Workshop Three (David Mohrbacher)
• Tensleep MPZ & ROZ Reservoir Characterization (Peigui Yin)
• Residual Oil Zone (ROZ) Development (Guest speaker: Steve Melzer)
• Tensleep Reservoir Fluid Phase Behavior and CO2 Flooding (TBD)
• CO2 Foam Flooding (TBD)
• CO2 Supply and Pipeline Updates in Wyoming (Glen Murrell)
• Case Study – Frannie Field (Shaochang Wo)
• Case Study – Other Fields (Operators)
Future Workshops

Time and Location TBD, 2013 - 2014

- Waterflooding and IOR for Minnelusa Reservoirs
- ASP in Minnelusa Reservoirs
- Fractured Reservoirs and Conformance Improvement
- Other Workshops in Demand
Lab Equipment Procurement & Capability

- Three Core Flood Apparatus: Liquid and gas flooding at HPHT*
- Phase Behavior Apparatus: Bubble and dew point pressures, swelling tests
- GOR Apparatus: GOR (GWR) measurement
- Slim Tube Apparatus: Miscibility study
- Agilent GCs: Gas and oil compositional analyses
- Visual Cell: HPHT observation of fluids
- HPHT Tensiometer/Operating System: Interfacial tension measurements
- Cambridge Viscometer: HPHT viscosity
- Anton Paar Stabinger: Viscosity and density
- Automatic High Sensitivity Wide Range Cryoscope: Molecular weight
- Rocker & HPHT Cylinders: Fluid validation and preparation

* HPHT: High Pressure High Temperature
Capability & Planned studies for EORI Lab Group

• Swelling tests for crude oils in potential fields with CO$_2$–EOR
• CO$_2$ miscibility Study
• CO$_2$ foam stability study
• ASP studies for Minnelusa and Tensleep at reservoir conditions
• Polymer and gel studies for Minnelusa and Tensleep formations at reservoir conditions
• Wettability and Modification in Fractured Reservoirs
Acknowledgements

- School of Energy (SER) for Partially Funding the Laboratory Equipment
- Support from the EORC Members
Thank You!