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Selective Water Reduction Systems: Where Have We Been and Where Are We Going?

Larry Eoff
Halliburton

Society of Petroleum Engineers Distinguished Lecturer Program
www.spe.org/dl
Outline

• General introduction to water issues, water production issues, chemical water control systems
• Discussion of mechanism, chemistry of selective systems
• Past and present selective systems
• Case histories
• Future of selective systems—improvements and new areas of usage
Cost of Water

- Cost of water production
  - Expense to lift, dispose, and re-inject produced water
- Other associated problems
  - Sand production
  - Corrosion
  - Scale
  - OIL/GAS PRODUCTION DECLINE

Average Production of Oil Wells:
~ 3 BWPD/1 BOPD
To ~ 7 BWPD/1 BOPD
Water Reduction Chemical Treatments

Timed Sealants

Completely Seal Treated Zone
Selective Systems for Reducing Water

- Reduce water permeability more than oil/gas permeability
- Require no zonal isolation, bullhead treatments
Water Production Problems Near Wellbore/Reservoir

Fluid Flow Behind the Casing

Watered out zone

Water Coning

Hydraulic fracture intercepting A water zone nearby
Ideal Candidate for a Water Control Treatment
Poor Candidate for a Water Control Treatment
Selective System Mechanisms

polymer adsorption in water layer

polymer adsorption in oil layer
Where Have We Been: Chemistry, Lithology, Problems

Few products have seen sustained usage

Polyacrylamide
Xanthan
Scleroglucan
Acrylate copolymers

Sandstone, Carbonate

High-permeability streaks, coning, interwell communication, stimulation into water
Hydrophobically Modified Polymers
Typical Lab Results

![Bar Chart]

- **Permeability (md)**
  - **Oil Core**
  - **Water Core**

- **Initial Permeability**
- **Final Permeability**
Selective System

Sandstone Gas Reservoir

- 25 millidarcy
- 10 ft interval
- Bullhead treatment, 3% polymer solution, KCl brine + surfactant spearhead preflush
Selective System, Sandstone Gas Reservoir

<table>
<thead>
<tr>
<th></th>
<th>Water (BWPD)</th>
<th>Gas (mscfd)</th>
<th>Water/Gas Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before treatment</td>
<td>14</td>
<td>254</td>
<td>56</td>
</tr>
<tr>
<td>2 months after treatment</td>
<td>9</td>
<td>396</td>
<td>23</td>
</tr>
<tr>
<td>5 months after treatment</td>
<td>0</td>
<td>380</td>
<td>0</td>
</tr>
</tbody>
</table>

- ROI in 2 months
- Added value from less frequent de-watering
Where Are We Going?

• Selective systems have seen growth into new areas
  – Fracturing
  – Acidizing
  – Sand control
  – Coiled-tubing applications
• These have greatly increased the usage of these chemicals
Combinations with Stimulation
Fracturing Applications

- SPE 84511
- Treated well had ~1/2 BWPD vs offset
- Treated well had 53% more oil vs offset
Acidizing Applications
Acidizing Applications

- SPE 103771
- Carbonate reservoir, 100% of acid treatments result in increased water cut
- 22% of treated wells showed decreased water cut, 67% no change in water cut, 11% increased water cut
- All treated wells showed substantially higher oil production than non-treated wells
Coiled Tubing Applications

- Coiled tubing & nitrogen clean out
- Horizontal open hole
- Could not maintain circulation
- Full circulation after 10 bbl Selective System pill
Where Are We Going?

• Improvements for water reduction are still needed
  – improved chemistries
  – more attention to candidate selection
    • Biggest obstacle may be over-selling
    • selective systems are not a cure-all for water production

• Growth areas – injection wells
Conclusions

• Conformance treatments can have many positive impacts
• Selective Systems are not the answer to all water production problems
• While numerous chemicals have been proposed as selective systems, few have seen sustained usage
• Major advancements for these systems have been seen in stimulation, sand control and coiled tubing applications and there appear to be growth opportunities into other areas
Take Home Thought

• Selective Systems DO work and can be used for more than standard water reduction operations
• Think OUTSIDE THE BOX for new applications
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