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Formation Damage – Any Time, Any Place, Any Where

Michael Byrne
Senergy
Lecture Outline

• Definition of damage and cost
• When does damage occur?
• At what stage of field development does damage occur?
• Where does damage occur?
• Damage Mechanisms – Some Examples
• Conclusions – Any time, any place, any where, any how……
Formation Damage can be defined as any reduction in near wellbore permeability which is the result of “any stuff we do”

such as drilling, completion, production, injection, attempted stimulation or any other well intervention
What is the impact of damage?

- Shell has estimated that at oil price of less than $20 / barrel the cost of damage on Shell operated assets was $1 billion / year.
- Shell, at that time, was producing roughly 3.3 % of total world production.
- $70 / barrel and global perspective means current best estimate for cost of damage due to deferred production and dealing with damage is $100,000,000,000 / year
Cost versus Value

• How much does our industry currently spend on understanding and avoiding formation damage?
  • Maybe $100 million?
  • Or 0.1 % of the cost!!
When does damage occur?

- Drilling
- Completion
- Attempted Stimulation
- Production
- Well Intervention
- Injection
## Damage Risk Assessment

<table>
<thead>
<tr>
<th>Operation</th>
<th>% of total damage</th>
<th>Impact / removable?(1-5)</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>25</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Completion</td>
<td>25</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Attempted Stimulation</td>
<td>15</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>Production</td>
<td>15</td>
<td>3</td>
<td>45</td>
</tr>
<tr>
<td>Well Intervention</td>
<td>10</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>Injection</td>
<td>10</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>
For example: Damage During Attempted Stimulation

- Iron dissolution and precipitation
- Fines Migration
- Asphaltene deposition
- Fracture fluid damage
- Formation Failure
- Sludge
Acid Stimulation

• “There will be dissolution!”
• “There will be precipitation!”
• “Know your reservoir”
  – Dr Hisham Nasr El Din (Texas A&M)

• “Simulate before you stimulate”
  – Computer and laboratory
When is Formation Damage Important?

- Exploration wells
- Appraisal wells
- Development wells
Exploration and appraisal wells

- Undeveloped Discoveries – What if all exploration well test data is tainted by damage?
- Greater Damage in Exploration and Appraisal wells
  - Well objectives
  - Design of fluids
- Prospect Evaluation often ignores damage
- Damage / Productivity potential is the critical factor in many reservoir types from tight gas to friable heavy oil
- Reference SPE 107557, 115690 (Breagh Field)
Damage Mechanisms – Some Examples

• Example of the impact on well productivity
• Examples from laboratory simulation studies
Near wellbore inflow modelling

Advances…..

Pressure difference: X%
Vertical Open Hole Versus C&P
Vertical Well Pressure Profiles
Fluid has been retained in the micropores between the chlorite platelets

90% reduction in permeability

Solution was to treat with solvent, reduce interfacial tension and release most of the retained fluid – very successful in a laboratory and in the well

(Photographs courtesy of Corex UK Ltd)
Fines Migration
Myth or Reality?

• What are fines?
• Clay?
• <44 micron?
• <45 micron?
Fines Migration - Reality

- Fines are…….
  - “Any part of a rock that can move through or within the pores of the rock”

- Fines migration is very common, very complex and deserves our care, understanding and attention!

- Solutions to this problem can include reducing near wellbore flow rates, using less damaging fluids or even stabilising fines – see SPE112455
Example of Fines Migration
From SPE 107758 (courtesy of StatoilHydro)

Pre-test  Post-test
Carbonate Reservoirs

- 60% of current proven conventional reserves are located in carbonate reservoirs
- Formation Damage exists in carbonate reservoirs but is different from that in clastic reservoirs
- Consideration needs to be given to design of the wellbore / reservoir conduits interface. This is where damage and stimulation matter most and for carbonates can be difficult to model accurately
Example of whole mud losses to a fracture system (2mm apertures)
Formation Damage Any Time

- Drilling
- Completion
- Production
- Injection
- Well Intervention
- Stimulation

(Photographs courtesy of Corex UK Ltd)
Any Place

- Exploration Wells
- Appraisal Wells
- Production Wells
- Injection Wells
- Well Re-entry, Re-completion
Any Where

- Damage at completion
- Mud cake
- Near Wellbore
- A bit deeper!
- Deep damage

SPE 68969 (Photograph courtesy of Corex UK Ltd)
Any How

- Pore Blocking
  - External – mud cake, particles etc.
  - Internal – introduced solids, fines, fluid retention, etc.

- Chemical
  - Dissolution and precipitation
  - Swelling, wettability etc.
Conclusions

- Formation damage is everywhere
- Understanding impact and mechanisms are the key
- We can minimise most formation damage through understanding
Thank You!

- Formation Damage – Any Time, Any Place, Any where

- Any ...........

- Questions??
Your Feedback is Important

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http://www.spe.org/events/dl/dl_evaluation_contest.php