Numerical Simulation of Reservoir based on Equivalent Characterization of Small Scale Seepage Barriers

—— QHD32-6 Oilfield

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Presently, the north area has come into high water-cut stage (80%) with low recovery factor (12.7%). By this situation, the remaining oil distribution becomes particularly important. Several wells have poor history matching which will bring an error distribution of remaining oil.
Numerical Simulation of Reservoir based on Equivalent Characterization of Small Scale Seepage Barriers

Formation of Meandering stream deposit

- Lateral accretion body: With the erosion of the concave bank, coarse materials form lateral accretion bodies in convex bank.
- Lateral accretion surface: The fine-grained materials drape on the lateral accretion bodies to form lateral accretion surfaces.
- Abandoned channel: At last, the river is filled with fine-grained materials to form mud plugs.

Formation of Meandering stream deposit

- Grid upscaling process
  - Fine geological model
  - Grid averaging
  - Reservoir model
  - Geological information loss
Local Grid Refinement (For short: LGR)

### Process
- Estimate the location
- Refine the grids
- Make a filter and adjust parameters
- Run the simulation case

### Limitations
- Huge number of grids
- Convergence problem
- Long calculation time
- Low efficiency
Equivalent Characterization Method (For short: ECM)

Process
- Estimate the location
- Make a filter
- Adjust the grids’ transmissibility
- Run the simulation case

Advantage
- Size and number of grids unchanged
- No convergence problem
- Short calculation time
- Hold the information of seepage barriers

Numerical Simulation of Reservoir based on Equivalent Characterization of Small Scale Seepage Barriers
In actual production (the blue line), the water cut of the well B20 tends to be stable after high aquifer was shut down in 2003, while it increases dramatically in 2009 because of the injection water of the well B14.

While in the reservoir model (the green line), the water cut of the well B20 rises because of the injection water of the well B16 in mid-term, while it tends to be stable after 2009 without injection water of the well B14.

Application of the New Method in Well Group B20

- **Model: Injected water of B16**
  - Production: No injected water
  - Data: 2006

- **Model: Less Injected water**
  - Production: Injected water of B14
  - Data: 2009
Result of the New Method in Well Group B20

Water cut of the well B20

- Injected water of B14
- No injected water of B16
Application of the New Method in North Area of QHD32-6 Oilfield

History Matching of Water Cut

- B19-Water cut
  - Observed data
  - Water cut of initial model

- A03-Water cut
  - Observed data
  - Water cut of initial model

- B12-Water cut
  - Observed data
  - Water cut of initial model

- B19-Water cut
  - Observed data
  - Water cut of new model

- A03-Water cut
  - Observed data
  - Water cut of new model

- B12-Water cut
  - Observed data
  - Water cut of new model

New Remaining Oil Distribution

- 76% +15% 91%
## Verification by New Adjusting Well

### The Log Interpretation of Water Flooded of New Adjusting Well G7H

<table>
<thead>
<tr>
<th>Vertical depth(m)</th>
<th>Initial model</th>
<th>New model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1145.92-1146.92</td>
<td>weak</td>
<td>weak</td>
</tr>
<tr>
<td>1146.92-1148.42</td>
<td>weak</td>
<td>middle</td>
</tr>
<tr>
<td>1148.42-1150.82</td>
<td>middle</td>
<td>serious</td>
</tr>
</tbody>
</table>

### The Coincidence Rate between the Log Interpretation and the Remaining Oil Distribution

![Profile map of well G7H in initial model](image1)
![Profile map of well G7H in new model](image2)
![Graph showing coincidence rate](image3)
Summary

1. In meandering stream deposit, the lateral accretion surface which has poor permeability takes an important influence on fluid flow, and it plays an important role in distribution of remaining oil.

2. There are several limitations by using conventional method (LGR), which were broke through by using Equivalent Characterization Method.

3. It is verified that the new model increased coincidence rate of history matching and accuracy of remaining-oil distribution by actual application.

4. The Equivalent Characterization Method can not only describe the lateral accretion surfaces, but also be widely used to describe the interface of various genetic sand bodies.
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Thank you!