Case Studies

Well Qungu-1, Tarim Oilfield
- Successful wire logging and casing running
- After 41 days incidents management (not related to drilling fluid), the drilling fluid still ensured smooth POOH and RIH
- High-yield at formation test

Madura oilfield, Indonesia
- Strong hydration and dispersion in upper mudshale formation
- Mid-lower limestone is highly permeable with high pressure
- Pruph limestone is friable and contains gas

More than 10 wells had been drilled since the discovery of the field, but were all abandoned because of frequently occurred drilling troubles such as borehole instability, well kick and lost circulation.

BH-WEI drilling fluid was used in well Maderderop-1 and well Dungok-1, achieving good results.
- Smooth POOH and RIH
- Successful wire logging and casing running
- Strong inhibition, no lost circulation
- No reservoir damage, density reduced by 0.12-0.24g/cm³

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Iraq

20 wells were successfully drilled and completed by using BH-WEI drilling fluids, without incidents, problems or discharge.

In Halfaya, the first directional well was successfully drilled at the first attempt with the maximum density up to 2.35g/cm³. In Missan, the record of shortest drilling period of 45.96 days was achieved with the daily footage of more than 400 meters.
CNPC’s proprietary BH-WEI drilling fluid system is used for high-temperature, high-pressure and high-gypsum salt-content formations. It has overcome the shortage of traditional drilling fluids of its kind such as high solid content, poor stability and weak inhibition, which may affect the rheological property of drilling fluid and cause borehole collapse or hole shrinkage.

In the R&D of BH-WEI drilling fluids, we incorporated three technical countermeasures: 1) increasing base brine density to minimize the quantity of added weighting materials in order to avoid affecting the rheological property; 2) offering a reductive environment to remove dissolved oxygen in order to increase temperature resistance of additives; and 3) enhancing the inhibition to reduce filtrate activity in order to reinforce the anti-collapse ability.

Because water activity of organic salt solution is lower than most inorganic saturated salt water, the water in drilling fluid will not permeate into the rocks. Contrarily, the water in the rocks will permeate into the drilling fluid. Hence, rock debris and clay expansivity will be greatly reduced in the BH-WEI drilling fluid, so as to ensure stability of the borehole walls.

**Thermostability Evaluation**

- Properties of the drilling fluid system with the density range of 1.80-2.60g/cm³ and 220°C thermostability

**Pollution Resistance Evaluation**

- Pollution resistance evaluation of BH-ATH (γ =2.5g/cm³, 220°C heating)

**Field Application**

- Applied in 205 wells and 200 of them have been completed in China: Hainan, Tarin, Qinghai, Chenghai, and Dagang Oilfields

- Iraq: Halfaya and Missan Oilfields

**Gypsum Salt Resistance Mechanism**

- Dissolution of NaCl, CaSO₄ in organic salt solution (%)

**Temperature Resistance Mechanism**

- Organic salt soluble X₂R₂(CO₂)₆

**High Density with Low Solid Content Mechanism**

- Relationship between complex organic salt dosage and density

**Inhibition Mechanism**

- Water activity of different organic salt solutions

**Key Additives**

- Complex organic salt
- Filtration reducer
- Anti-gypsum salt instability
- Inhibitive anti-sieving agent
- Inhibitive lubricant

**Experimental condition:**

- Core permeability 215×10⁻³µm²
- 150°C
- Final return permeability was 87%
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**Temperature Resistance Mechanism**

- Strong inhibition
- 220°C temperature resistance
- Maximum density up to 2.6g/cm³
- Saturated gypsum salt resistance
- Gypsum insolubilization

**Gypsum Salt Resistance Mechanism**

\[ \text{Dissolution of NaCl, CaSO}_4 \text{ in organic salt solution (\%)} \]

<table>
<thead>
<tr>
<th>System</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
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<td>BZ-WJ-I</td>
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<tr>
<td>BZ-WYJ</td>
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<td>19.7</td>
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</tbody>
</table>

**High Density with Low Solid Content Mechanism**

**Inhibition Mechanism**

The mudstone sample immersed in the BH-WEI fluid recorded an expansion rate of only 10% after 40 hours, and eventually 11.4% after 66 hours.

**Key Additives**

- Complex organic salt
- Filtration reducer
- Anti-gypsum salt stabilizer
- Inhibitive anti-caking agent
- Inhibitive lubricant

**Field Application**

Applied in 205 wells and 200 of them have been completed in China: Hainan, Tarin, Qinghai, Chenghai, and Dagang Oilfields.

**Iraq: Halfaya and Missan Oilfields**

Experimental condition: core permeability 215×10⁻³µm², 150°C. Final return permeability was 87%.

**Experimental conditions**

- Core permeability: 215×10⁻³µm²
- Temperature: 150°C
- Final return permeability: 87%
More than 10 wells had been drilled since the discovery of the field, but were all abandoned because of frequently occurred drilling troubles such as borehole instability, well kick and lost circulation.

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