Extreme HP/HT well control - Closing the technology gap

Chris Morrissey
Castrol Energy Technology
Introduction

With the continuing challenge to develop hydrocarbon fields which are deeper and hotter, closing the many technology gaps to provide safe and reliable operation remains an industry priority.

Focus for this presentation

1. Present HP/HT experience to date
2. Review limiting factors of hydraulic fluids in control hardware
3. Explore a new system approach
4. Technical summary
Existing Operational Experience

- **Water-glycol**
  - (CASTROL TRANSAQUA HT2)
  - Canyon Express
  - Akpo
  - Thunder Horse
  - Erskine
  - Kristin
  - Åsgard
  - Elgin/Franklin
  - West Franklin
  - 120°C
  - 135°C
  - 150°C
  - 140-150°C
  - 135-167°C
  - 180°C
  - 199°C

- **Synthetic**
  - (CASTROL BRAYCO MICRONIC SV/3)

Both fluids types have their place in delivering high levels of reliability.

As an industry, >90% of subsea systems run on water-glycol fluids.

Synthetic fluids have enabled control of increasingly challenging reservoirs.
Thermal Effects on Hydraulic Fluid & Control Hardware

**CHALLENGES**
- Long term extreme Temp/Press
- Seal degradation and extrusion
- Uncertain seal life
- Heat soak into actuators
- Rod and Piston seals life
- Material data gaps
- Tree insulation
- Fluid breakdown
- Deposit formation
- Increase in acidity
- Materials attack

**RISK MITIGATION**
- Thermal FE analysis
- Polymer LET (Norsok M710, API6J1)
- Long term fluid aging
- Functional equipment test
- Time & Cost $$$$ 
- Equipment availability
- Relevant standards
# Fluid Comparison – Aqueous v Synthetic

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Aqueous Control Fluid</th>
<th>Synthetic Control Fluid</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>Water / MEG / Additives</td>
<td>Synthetic Hydrocarbon / Additives</td>
<td>Different properties</td>
</tr>
<tr>
<td>Viscosity @ 0°C</td>
<td>8 cSt</td>
<td>20 cSt</td>
<td>Long offsets</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.04</td>
<td>0.83</td>
<td>Deepwater</td>
</tr>
<tr>
<td>Upper Thermal Limit</td>
<td>177°C (350°F)</td>
<td>204°C (400°F)</td>
<td>uHP/HT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>230°C (450°F) Qual DHSV</td>
<td></td>
</tr>
<tr>
<td>Materials Compatibility</td>
<td>Good</td>
<td>Excellent</td>
<td>Critical Materials Protection, Storage</td>
</tr>
<tr>
<td>Environmental Compliance</td>
<td>OSPAR No Substitutable</td>
<td>OSPAR No Substitutable</td>
<td>Identical Testing Suite Similar performance</td>
</tr>
<tr>
<td>System Configuration</td>
<td>Open or Closed</td>
<td>Closed</td>
<td>Operator Choice</td>
</tr>
</tbody>
</table>
Subsea System Approach

### Conventional Hydraulic Systems

- **Open Hydraulic System**
  - Water based fluid
  - Discharge to sea

- **Closed Hydraulic System**
  - Synthetic or water based fluid
  - Returned to platform

### Split Hydraulic System

- **NEW APPROACH**
  - Water based fluid for LP tree hydraulics
  - Synthetic fluid for HP DHSV control

**Separate fluid lines in single umbilical**

**HP Line**

**LP Line**

**Return Line**

**HP Line (Synthetic Fluid)**

**LP Line (WB Fluid)**

**Extreme Temperature**

**IT’S MORE THAN JUST OIL. IT’S LIQUID ENGINEERING.**
Summary

• The push to uHP/HT may require a fresh look at system architecture – optimising systems to meet different needs of subsea and downhole control

• Aqueous and synthetic fluids both have good environmental profiles and go through the same rigorous testing

• Synthetic fluids already qualified with DHSV at 230°C (450°F), with good stability up to 260°C (500°F)

• Continued investment in R&D is imperative to support facilities to qualify new materials and components, including operational fluids

QUESTIONS?