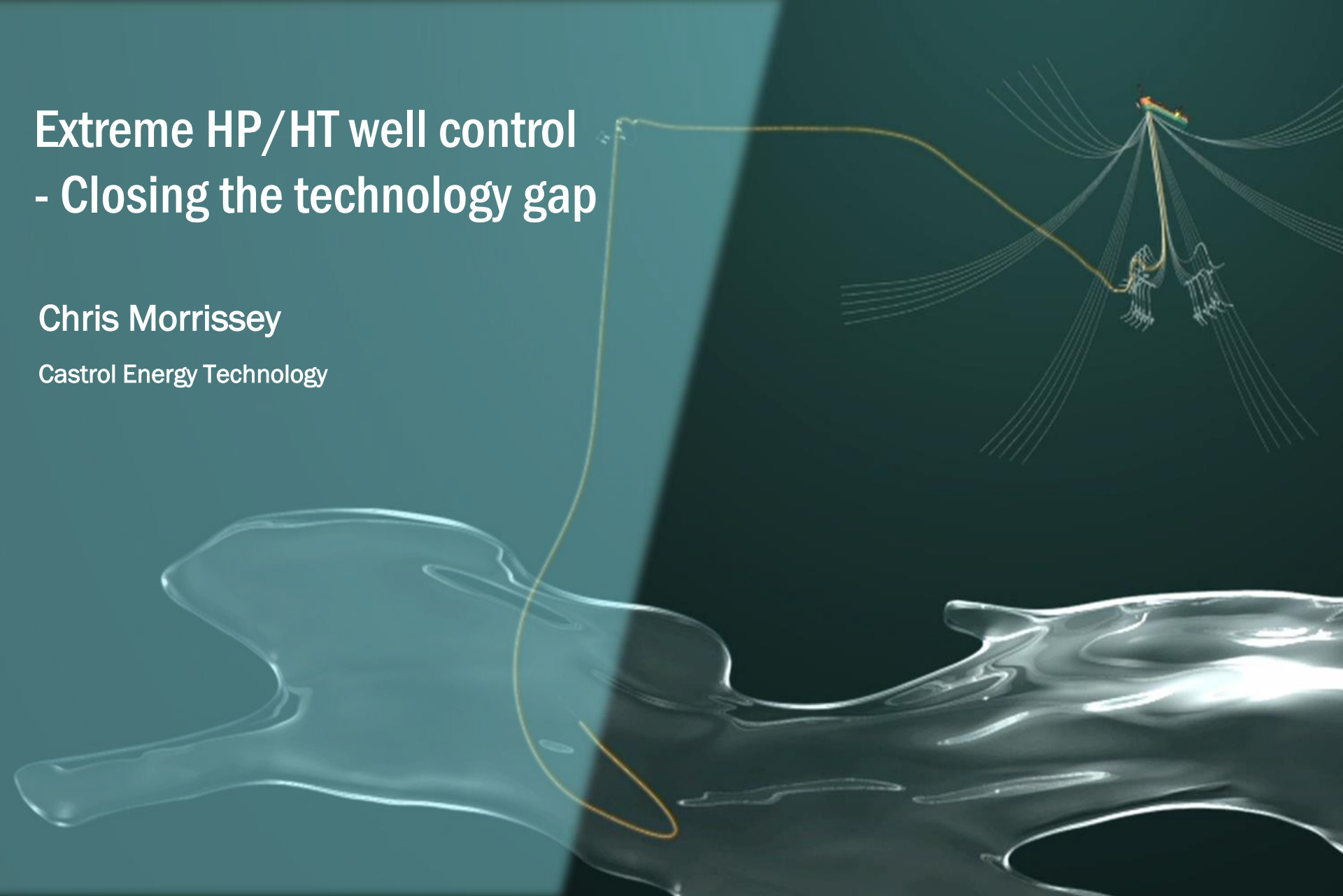


# Extreme HP/HT well control - Closing the technology gap

Chris Morrissey

Castrol Energy Technology

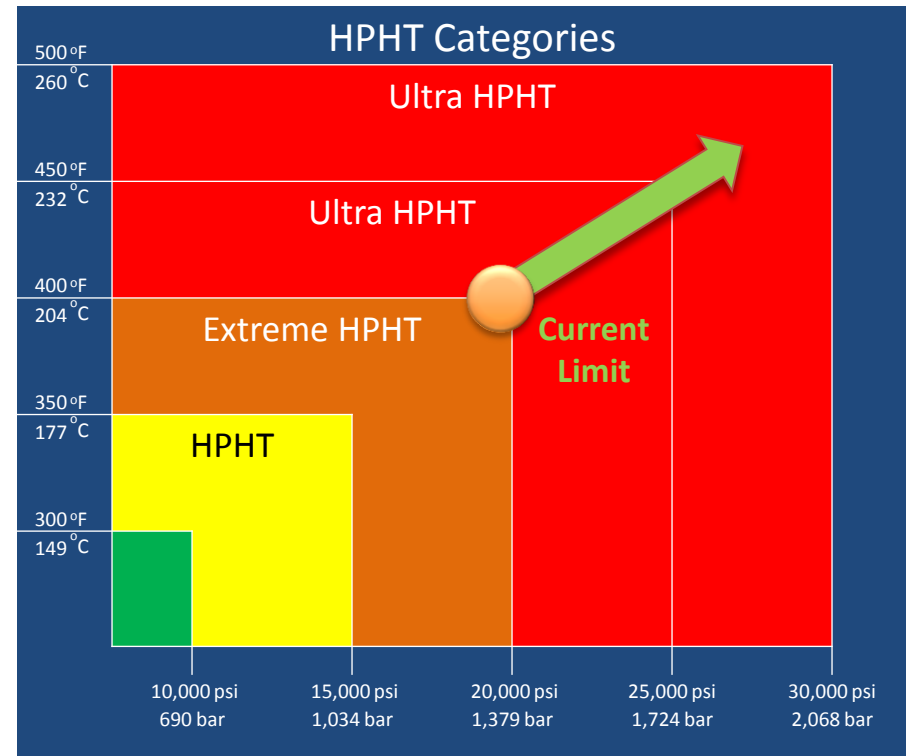


# Introduction

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)

(CASTROL BRAYCO MICRONIC SV/3)

Synthetic

Canyon Express  
Akpo

Thunder Horse

Erskine

Kristin

Åsgard

Elgin/Franklin

West Franklin

120°C

135°C

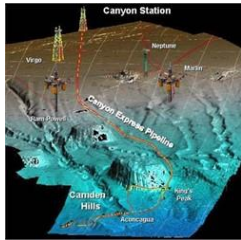
150°C

140-150°C

135-167°C

180°C

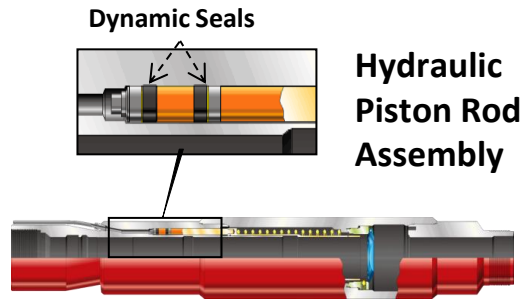
199°C



- 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

## Downhole Safety Valve



Images courtesy of Halliburton

## Subsea XTree



## Hydraulic Fluid



Aqueous

Synthetic

## CHALLENGES

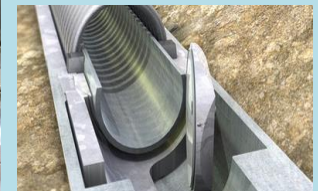
- Long term extreme Temp/Press
- Seal degradation and extrusion
- Uncertain seal life
- Heat soak into actuators
- Rod and Piston seals life
- Material data gaps
- Tree insulation
- Fluid breakdown
- Deposit formation
- Increase in acidity
- Materials attack

## RISK MITIGATIONS

- Thermal FE analysis
- Polymer LET (Norsok M710, API6J1)
- Long term fluid aging
- Functional equipment test

## IMPLICATIONS

- Time & Cost \$\$\$\$
- Equipment availability
- Relevant standards

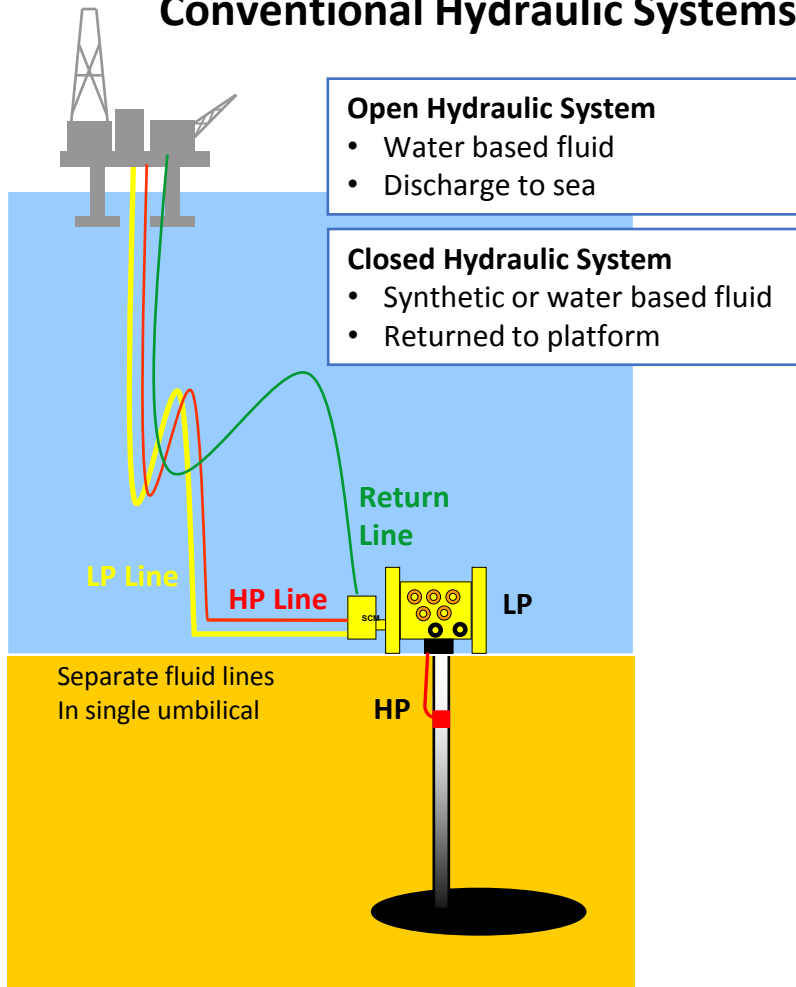


# Fluid Comparison – Aqueous v Synthetic

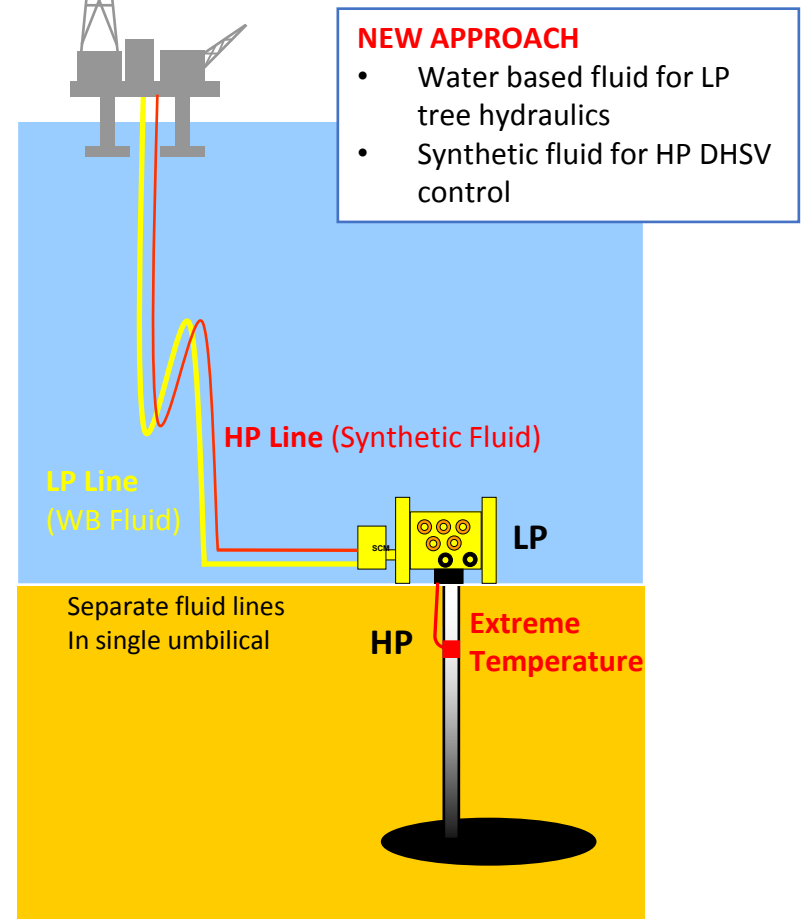
| Parameter                   | Aqueous Control Fluid     | Synthetic Control Fluid                  | Significance                                   |
|-----------------------------|---------------------------|--|--|
| Chemistry                   | Water / MEG / Additives   | Synthetic Hydrocarbon /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

# Subsea System Approach

## Conventional Hydraulic Systems



## Split Hydraulic System



IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.



# Summary

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- 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 ?