NEW SUBSEA FLUID TECHNOLOGIES ENABLE SUCCESS IN LONG OFFSET GAS

Sam Johns, Chris Morrissey
Castrol Global Marine & Energy
Subsea Controls Down Under, Perth – 24th October 2018

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Agenda

New subsea fluid technologies enable success in long offset gas

- Context
- The challenge of new operational conditions
- Managing gas hydrate risk through technology
- New barrier fluid supports subsea compression
- Summary and key learnings

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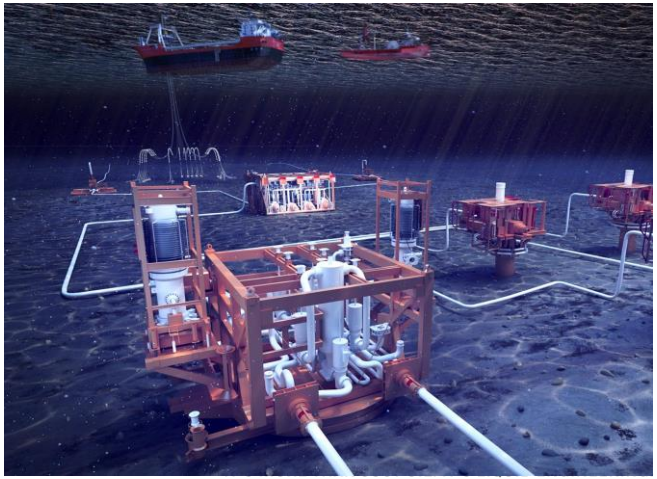
Context

The focus on offshore gas

- Production predicted to triple over the coming years, to around 16,000 bcfd by 2025*
- Top ten countries in the world hold over 96%, over 200 trillion cubic feet (tcf) of all remaining reserves*
- Field development typically through use of floater, increasing use of long tie back to shore or by FLNG
- New subsea compression technology will boost production and enable new possibilities

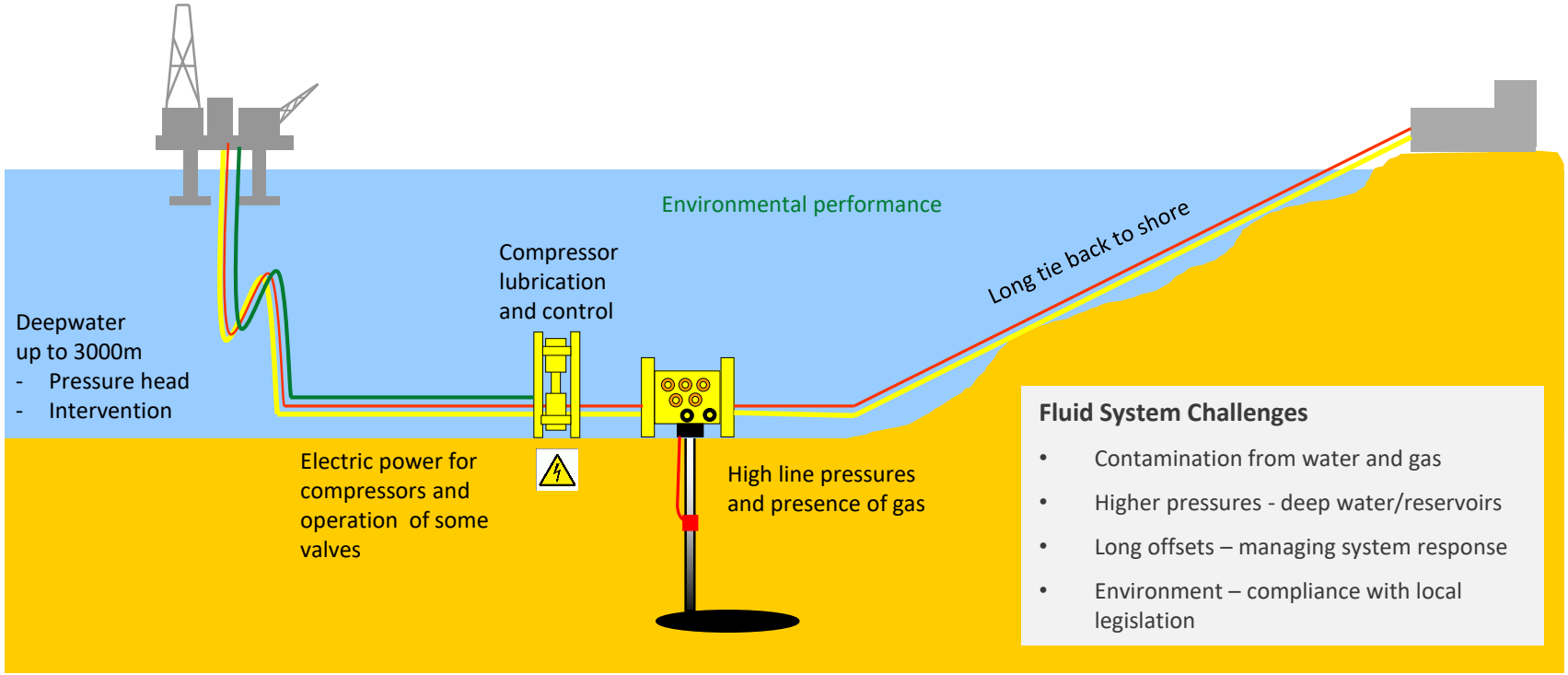
Operator requirements

- Cost effective solutions
- Uptime and cash flow assurance
- Operational efficiencies and long equipment life
- Local environmental compliance



*Ref - https://www.offshore-technology.com/comment/ultra-deepwater-gas-production-set-triple-2025/

New operational conditions



Fluid System Challenges

- Contamination from water and gas
- Higher pressures - deep water/reservoirs
- Long offsets – managing system response
- Environment – compliance with local legislation

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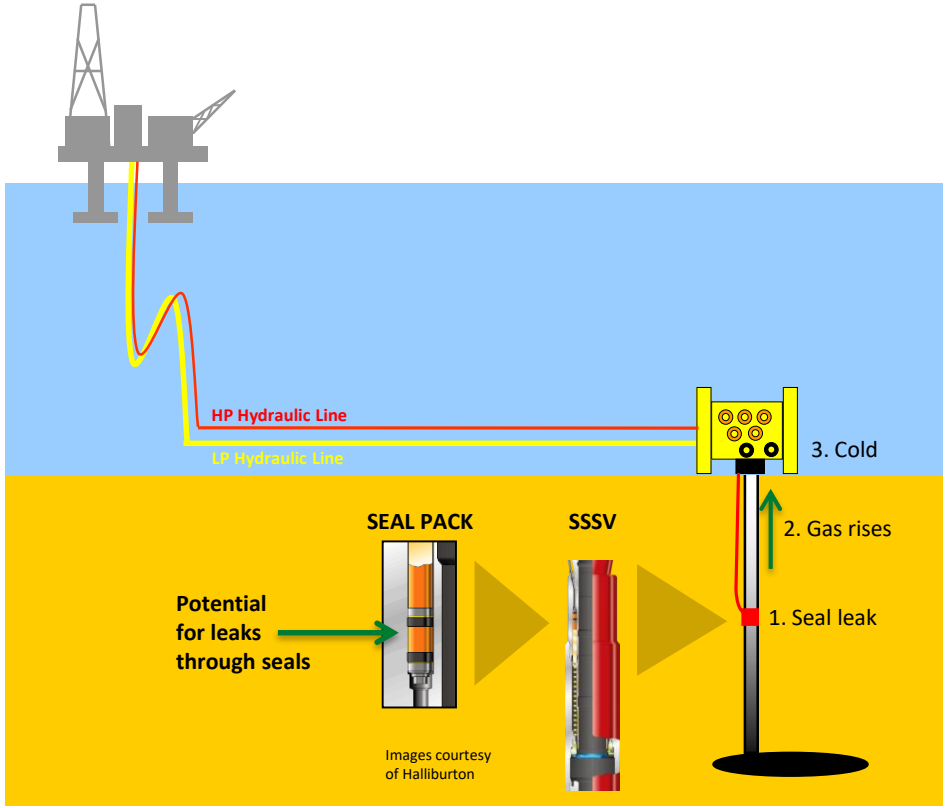
Risk of hydrate blockage in hydraulic lines



1. Gas enters hydraulic system via SSSV actuator; when valve closed pressure delta across seals (exposed to well bore gas pressure)
2. Gas migrates upwards along HP hydraulic line towards tree
3. Gas then sits in cold control line between penetrator and SCM
4. On re-applying pressure to open SSSV, gas is now exposed to high pressure, seabed temperature and water contained in fluid; risk of hydrate formation and line blockage = failure to open

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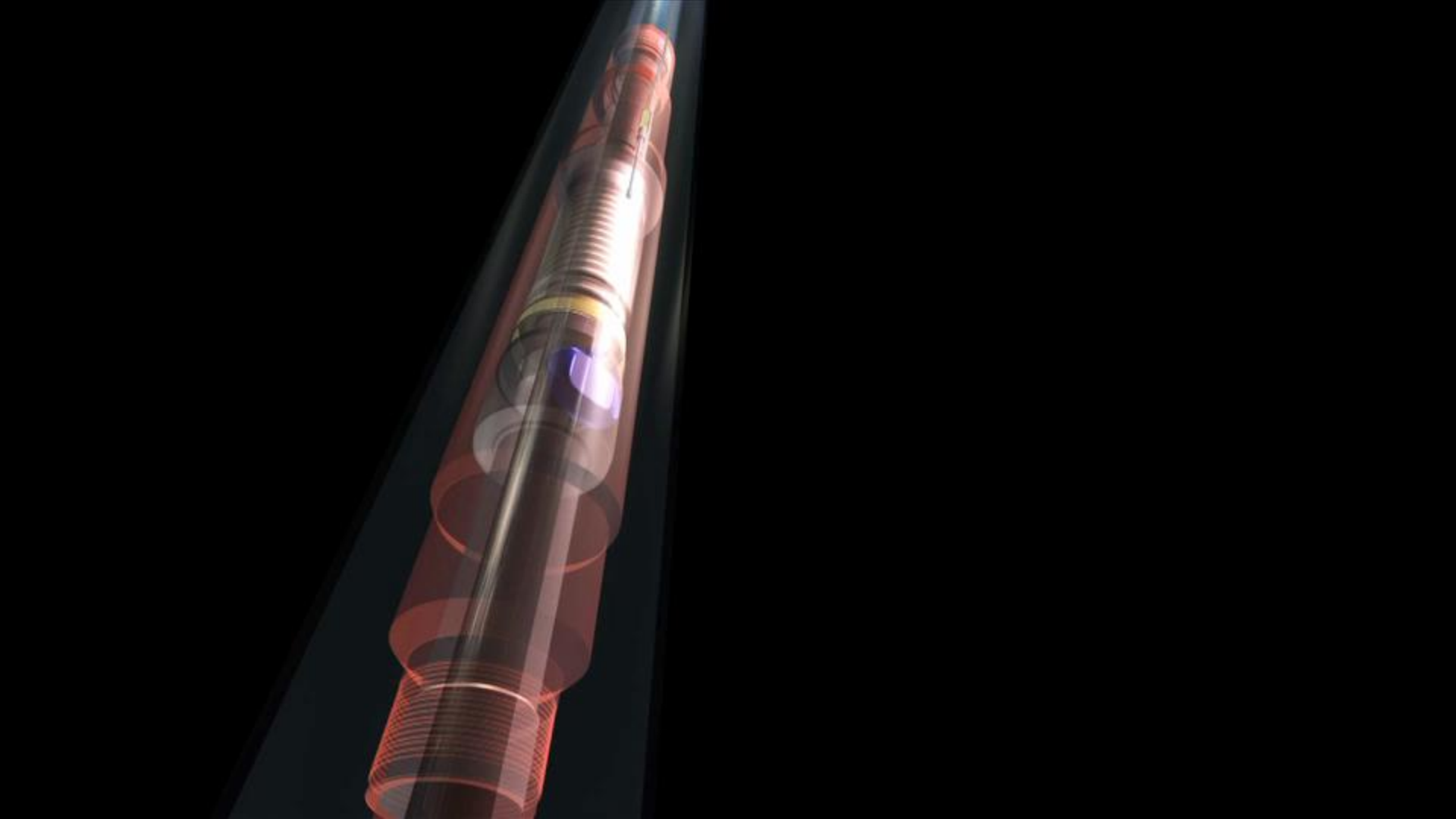
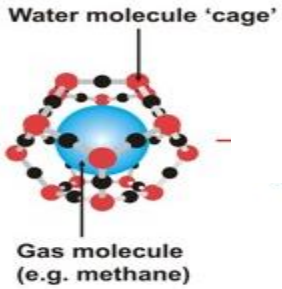


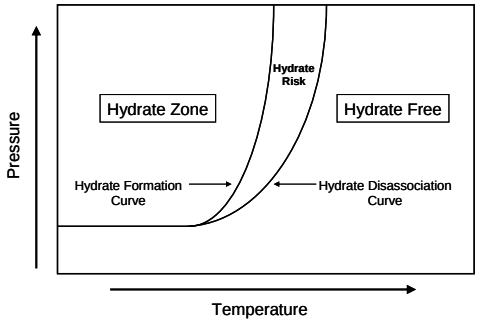
Gas Hydrates



WHAT ARE THEY ?

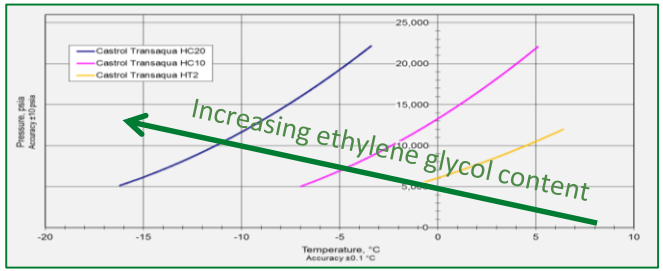
- Gas hydrates are ice-like crystalline molecular complexes
- They form under *pressure* from mixtures of *water* and suitably sized 'guest' *gas* molecules.
- Gas hydrates will form even at *temperatures* well above the melting point of water ice.
- The *gas composition* has a significant efffect on the conditions under which hydrates will form.

- **HOW CAN YOU ASSESS THE RISK?**
- Generate hydrate curves by exposing the control fluid containing methane gas to varying temperatures and pressures.
- Algorithms can be used to modify the curve for the actual gas composition for a specific well.
- The presence of hydrocarbons with molecular weight higher than methane moves the dissociation curve to the right.



Control Fluid technology - Opportunities for effective gas hydrate risk management

EFFECT OF PRODUCT COMPOSITION

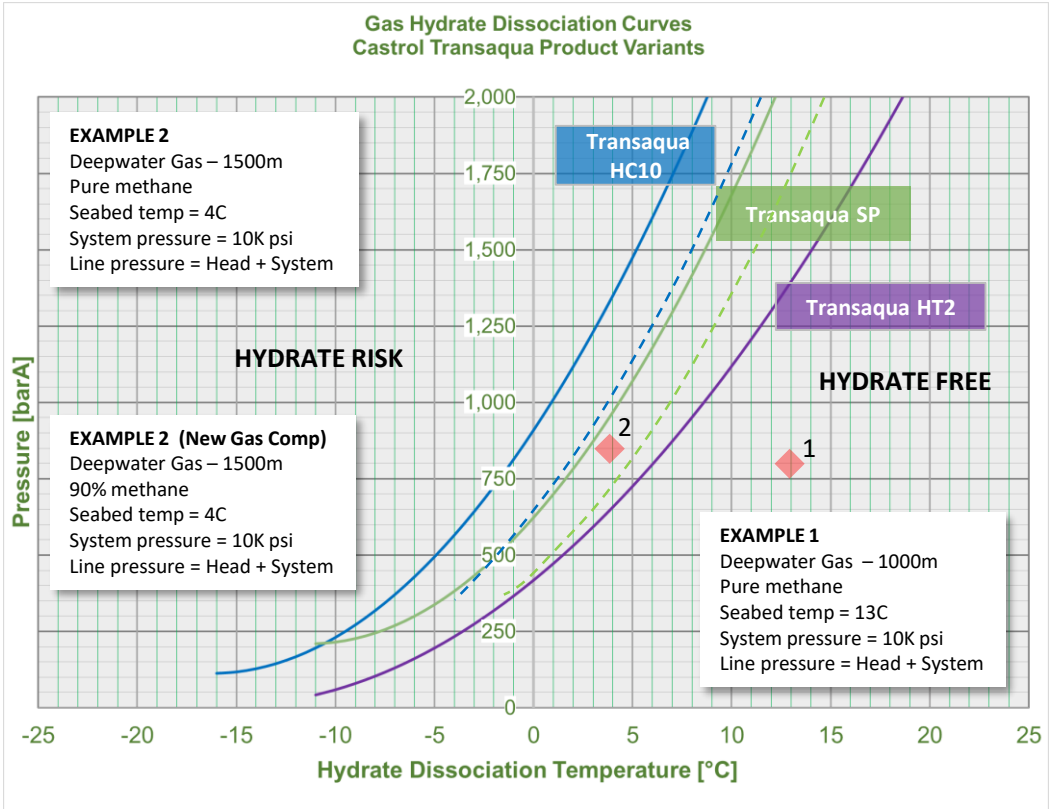


Typical Standard Fluid Composition

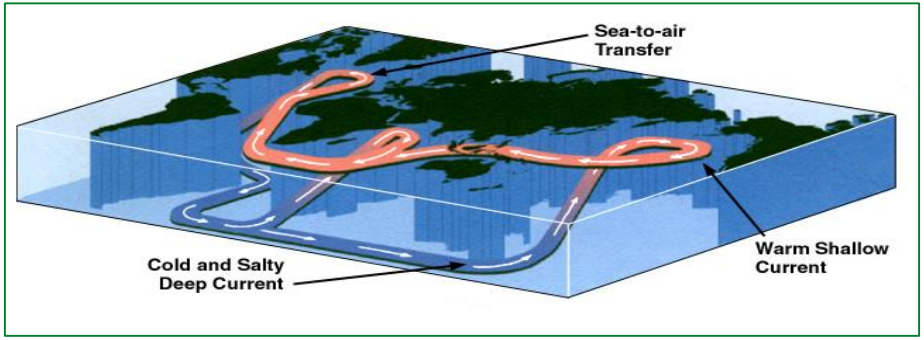
Water 50%	MEG 40%	ADD 10%

- Water-based control fluids rely on (typically) ethylene glycol to prevent freezing
- Ethylene glycol is a thermodynamic hydrate inhibitor
- Thermodynamic inhibitors shift the hydrate equilibrium conditions towards lower temperatures and higher pressures

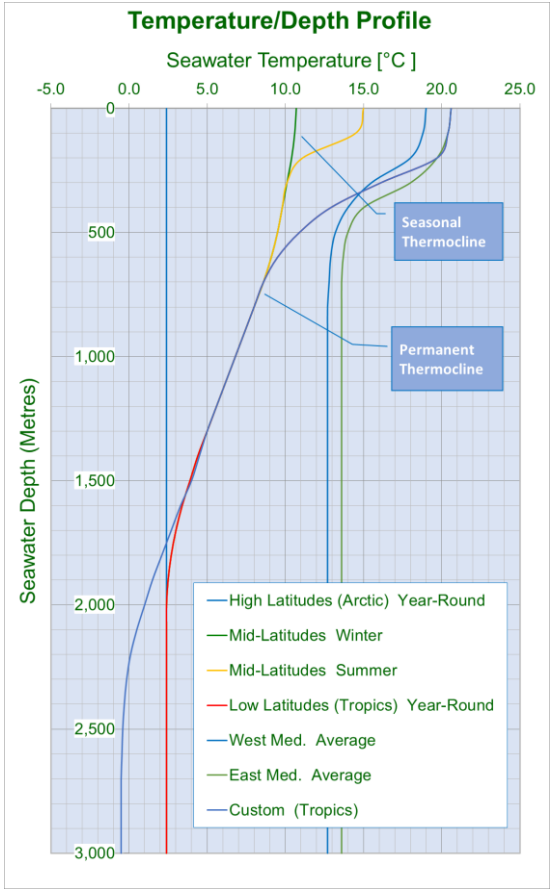
FLUID SELECTION FOR SUBSEA GAS PROJECT



Key data - Seabed Temperature



- Seabed temperatures are driven by ocean currents and density gradients.
- In deep water seabed temperatures average 2.7°C (33.3°F), and can be as low as -1°C (30.2°F).
- Low seabed temperatures can occur in shallow water in cold climates such as the arctic.
- In enclosed bodies of water such as the Mediterranean, deep doesn't always mean cold.



Risk Mitigation

Early recognition of hydrate risk is essential to minimise impact on costs and schedule

FLUID SOLUTIONS

- Most readily-implemented option is to select a fluid with hydrate-inhibiting characteristics…
- An aqueous fluid such as Castrol Transaqua HC10 with enhanced hydrate inhibition characteristics can be utilised
- A non-aqueous fluid such as Castrol Brayco Micronic SV3 can be utilised – this removes the water component from the hydrate equation

HARDWARE SOLUTIONS

- Can be introduced if technically feasible
- Eliminated gas leak path by using a SSSV design with complete isolation between well bore and hydraulics
- Reduce the HP system pressure if sufficient design headroom or through use of a “dome-loaded” SSSV
- Seabed temperature is fixed, but trace heating of the exposed control line can be introduced.
- Minimise contamination with seawater or completion fluid ingression during SSSV installation

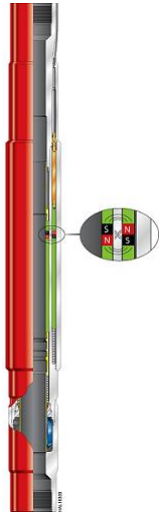


Image courtesy of Halliburton

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New barrier fluid for subsea compressors

Subsea Compression Challenges

- Putting complex and sensitive rotating equipment on the seabed
- High power output, shaft speeds and operating temperatures puts strain on lubricant, bearings and mechanical seals
- Environmental concerns drive need for lubricants with reduced environmental impact
- Long term commitment for product support

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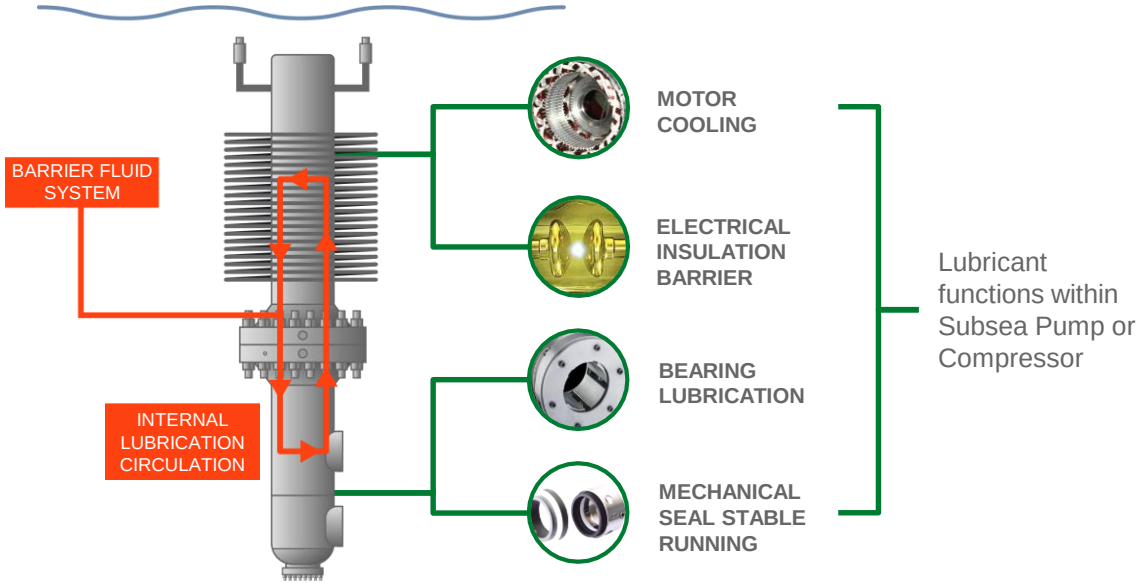
Barrier fluid functions

Barrier fluid is the life blood of the compressor system

- Supplied from surface through an umbilical (Fluids + power)
- Circulates within unit to perform key functions
- Is critical to reliable operation and maximum output



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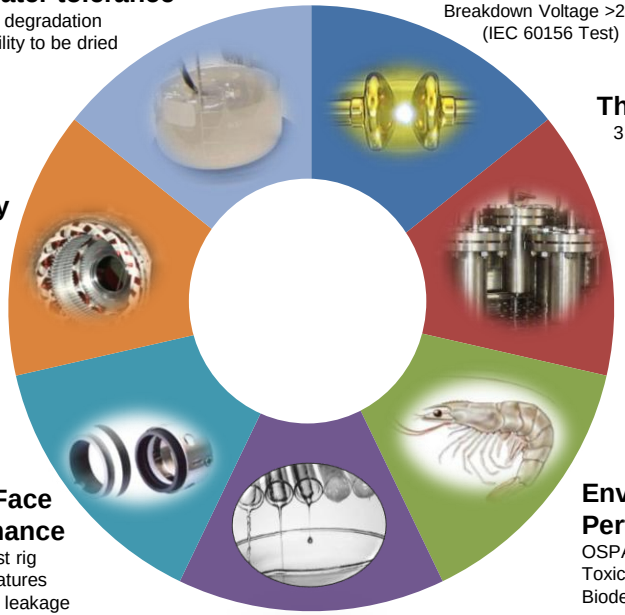
Fluid Development

Fluid was co-engineered in collaboration with key equipment OEM



Water tolerance
No degradation
Ability to be dried

Electrical Insulation
Breakdown Voltage >20KV
(IEC 60156 Test)

Thermal stability
3 month stability test at 200°C+
Stable TAN, no deposits

Materials Compatibility
Motor windings
Insulation resins
polymers

Mechanical Face Seal Performance
Dynamic test on test rig
High Peak Temperatures
No deposits, stable leakage

Environmental Performance
OSPAR Testing
Toxicity, Bioaccumulation
Biodegradation

Viscosity
Low to reduce shear at high speed
(5Cst @40°C Typical)

KEY DEVELOPMENT CHALLENGES

- Selection of components to meet environmental needs
- Mechanical seal face cleanliness and controlled leakage
- Performance verification challenges – rig testing
- Changing technical requirements and specifications

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Summary

FINAL FORMULATION - **Brayco Micronic SBF ES**

New oil tailored for Subsea Compressors with no technical compromise

ENVIROMENTALLY RESPONSIBLE

- Improved environmental performance in comparison with conventional mineral oil products
- Biodegradable base oil technology

ENSURING RELIABILITY

- Extensive stress testing and qualified to TRL5
- Back compatibility with existing fluids

MAXIMISING PERFORMANCE

- Highly stable synthetic formulation
- Withstands breakdown under high loads and temperatures

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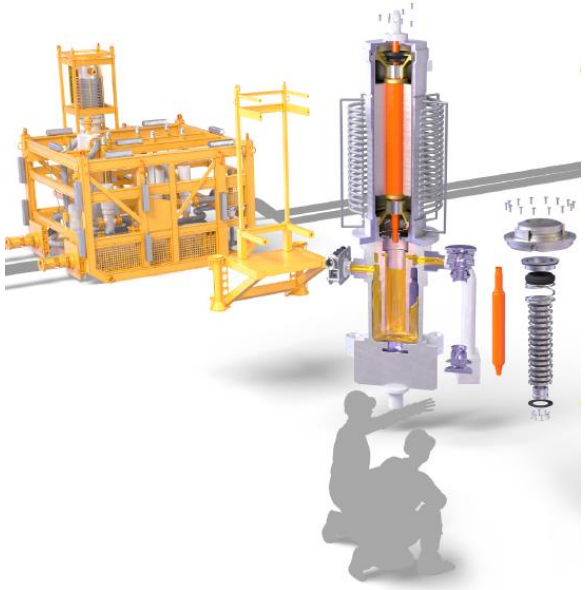
Summary

Fluids and lubricants are the life blood of subsea production and processing systems. Careful selection in collaboration with all stakeholders supports the monetisation of new gas opportunities

Key Learnings

- Deepwater and long offset gas projects present new field conditions which require careful assessment
- Early appraisal of hydrate risk and selection of potential solutions can avoid expensive system reworks and project delays
- Correct control fluid selection can mitigate the risk of line blockages, but accurate data on field conditions and gas composition is essential
- New dedicated barrier fluid technology for subsea compressors presents reduced environmental risk and increased performance



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