HYDRAFACT: Hydrate and Flow Assurance Consulting, Technologies

We know what’s in the pipeline

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Background (A Heriot-Watt Spin-Out Company)

• PVT research started in 1978
• Gas hydrate research started in 1986
• Centre for Gas Hydrate Research established in Feb 2001
• Centre for Flow Assurance Research (C-FAR) established in 2007
• Most of our projects are Joint Industry Projects

PVT: how water-hydrocarbon systems behave under different pressure and temperature conditions from reservoir to end user (and their properties)

Hydrates: Ice like compound form as a result of combination of water with gas molecules at high pressure and low temperature conditions that can block pipelines
### Background (A Heriot-Watt Spin-Out Company)

- Hydrafact was formed in 2006 as a Heriot-Watt University spin-out company to address:
  - The increasing demand from the industry
  - Commercialise the expertise developed through many years of research
- Now Hydrafact has some 12 full-time and part-time staff
- -200 to +350 °C and 3,000 bar

### What Do We Do?

- **Flow assurance** (ensuring uninterrupted and cost effective production from reservoir to end user)
  - Hydrates
  - Wax
  - Asphaltene
  - Corrosion
  - Salt
  - Emulsion
  - Foam
- **PVT, properties and phase behaviour of petroleum reservoir fluids** (how water-hydrocarbon systems behave under different pressure and temperature conditions from reservoir to end user)
- **Phase behaviour and properties of H₂S/CO₂-rich systems**
Range of Activities

• **Consultancy**
  - Technical advice, experimental, modelling

• **Software (HydraFLASH®)**
  - Hydrates, PVT and phase behaviour
  - Our Hydrate-Phase Behaviour software has been ranked the best in two independent evaluations

• **Technology Transfer**
  - HydraCHEK® for cutting inhibitor costs, has been successfully deployed in several countries (e.g., IPTC 13765/17835, SPE 166596)
  - KHI evaluation/testing techniques (SPE 164258)
  - Other technologies include, HydraSENS (IPTC 17835), KHI Removal/Recovery/Reuse

• **Training (open courses, in-house, hands on/resident)**
  - Theoretical and/or practical, basic to advanced, various topics
  - Courses include: Gas Hydrates & Flow Assurance, PVT, Petroleum Engineering for other Disciplines

• **Providing experimental facilities**
  - Up to 45,000 psia (3,000 bar), from -80 to 350 °C

Laboratories

• **Two hydrate laboratories**
  - More than 40 experimental facilities, including autoclaves, rocking cells, visual cells, variable volume cells, high pressure glass micromodels, GC-MS, capillary sampler, hygrometers, Quartz Crystal Microbalance, etc.

• **Two PVT laboratories**
  - Two Hg-free cells (up to 200 °C and 1,400 bar)
  - Speed of sound measurement cell
  - Slim tube
  - HPHT cell (up to 250 °C and 2,000 bar)
  - high pressure calorimeter (-196 to 200 °C)
Laboratories

- Centre for Flow Assurance Research (C-FAR)
  - Flow loop (1” dia. 40 m long, 200 bar, Moineau pump (PCP), inside an environmental chamber-15 to 20 °C)
  - GIANT (high pressure multi-purpose rig)
- Hydrafact Laboratory
  - Autoclaves and rocking cells
  - Ultra high pressure cell (3,000 bar)
  - High pressure rheometer (-40 to 200 °C and 400 bar)
  - FTIR, UV, wax flow loop, co-axial cold finger
  - Ebuliometer (+350 °C)
- H₂S laboratories

Typical Projects

- Flow Assurance (Hydrates, Wax) in Offshore Australia Field Developments
- Hydrates in Deadlegs, Hydrate Slurry Transportation
- Investigating CO₂ Transportation Challenges
- Avoiding Solid Formation in Diesel Fuel
- Wax Problem in a Gas Condensate Field
- Methanol Removal from NGL
- CO₂ Separation from Natural Gas
- Asphaltene Problem in a North Sea Field
- Monitoring Hydrate Safety Margin and Minimising Methanol Injection
- Water content in gas produced from a HPHT reservoir with high CO₂ content, experimental measurement and thermodynamic modelling
- Evaluation of Anti-Agglomerants in High Degree of Subcooling
- Investigating the Causes of a Compressor Drain Pipe Blockage in an Offshore Platform
- Evaluating the Risk of Hydrates in a Gas Lift System
Typical Projects

- Risk of hydrates in BOPs
- CO$_2$-CH$_4$-MEG-H$_2$O Hydrate Prevention and Phase Equilibria
- KHI Evaluation for Numerous Fields
- Comparative PVT Tests on a Lean Gas Condensate
- Density Measurements on CO$_2$-Rich Systems
- EOR, CO$_2$-Oil Minimum Miscibility Pressure and Swelling Tests
- Kinetic Hydrate Inhibitor Removal/Recovery/Reuse
- Hydrate Inhibitor Partitioning in Gas/Oil/Water
- Identifying Composition of Unknown Deposits and Finding Solvents
- Advice on Removing Hydrate Blockage (which was removed successfully)
- Hydrate Formation after a Choke
- Rheological Properties of Aqueous Polymer Solutions in EOR
- Risk of Asphaltenes Formation in CO$_2$ EOR or Commingled Flow
- Risk of Hydrates in a Sour Gas Offshore Field
- Custom Design Software Development (e.g., Multi-Phase Meters, Flow Loop, PV-Flash, etc)

Typical Projects

- Kinetic Hydrate Removal, Recovery and Reuse from produced water/rich MEG
- Supporting HydraSENS deployment (for detecting hydrate formation)
- Hydrate, Wax, Asphaltenes, Emulsion, Foaming, Compatibility tests for various reservoir fluids
- Various AA evaluation tests, including comparative studies using rocking cells and autoclaves
- Evaluating risk of hydrates in drilling fluids
- Hydrate blockage removal in an offshore wellbore
- Hydrates in heat transfer limited systems
- Wax inhibitor evaluation with/without shear
- Developing Guidelines for addressing hydrate problems in various stages of field development/operation
- Hydrates in saturated salt systems at pressures up to 28,000 psia
- Causes of solid deposition in diesel engines at 200 °C and pressures up to 45,000 psia
Some of our Hydrate Capabilities

- Gas mixture preparation, oil quality check, oil/gas analysis, recombination
- Predicting/measuring hydrate stability zone for various fluid systems, without/with salt/alcohol/glycol
- Determining the concentration of inhibitor required for hydrate prevention
- Evaluating Kinetic Hydrate Inhibitor and/or Anti-Agglomerant performance
- Evaluating the performance of combined KHI/alcohol/glycol
- Advising on how to remove hydrate blockage and time required
- Optimising inhibitor injection rate, while increasing reliability
- Providing/supporting HydraCHEK/HydraSENS deployments
- Supporting safe shut-downs/start-ups
- Supporting design for KHI removal, recovery and reuse
- Evaluating risk of KHI clouding in produced water reinjection/treatment and/or MEG regeneration units
- Evaluating hydrate risks in under-inhibited systems
- Dehydration requirement to avoid hydrate problems
- Evaluating hydrate risk in drilling/hydraulic fluids
- Sour gas, CO₂, H₂S capabilities
- Temperature as low as -80 °C and pressures up to 30,000 psia (2,000 bar)

Some of our Wax Capabilities

- Gas mixture preparation, oil quality check, oil/gas analysis, recombination
- Measuring Wax Appearance Temperature (WAT) and Wax Disappearance Temperature (WDT) for dead and live oils
- Cold Finger (conventional and/or co-axial) tests on dead or live oils
- Investigating the effect of shear on wax deposition (co-axial cell)
- Pour point measurements for dead and live oils
- Complete rheological studies of dead and live oils
- Investigating the effect of inhibitor on rheological properties
- Evaluating wax inhibitor performance
- Wax inhibitor dose rate optimisation
- Compatibility
Some of our Asphaltene Capabilities

- Gas mixture preparation, oil quality check, oil/gas analysis, recombination
- Measuring Asphaltene Onset Point in on dead or live fluids
  - heptane titration or
  - depressurisation or
  - fluid mixing (e.g., CO₂ injection)
- Evaluating asphaltene inhibitor performance
- Asphaltene inhibitor dose rate optimisation
- Predicting asphaltene phase boundary

Some of our PVT Capabilities

- Gas mixture preparation, oil quality check, oil/gas analysis, recombination
- Measuring bubble point and dew point and phase fractions
- Measuring density, viscosity, IFT
- Measuring composition of various phases (gas-oil-water) in equilibrium
- Conducting slim tube tests, minimum miscibility, swelling
- Forward contact, backward contact
- Measuring thermal properties of various fluid systems
- Determining rheological properties of dead/live systems