Hytra Hydrate Flow Loop

CSIRO has developed Australia's first hydrate flow loop to simulate natural gas production in pipeline conditions typical of deep-sea conditions off the North West Shelf (NWS) of Australia.

Understanding hydrate dynamic behaviour in gas production systems is essential for flow assurance in offshore gas fields.

CSIRO's gas hydrate flow loop (Hytra Loop) is used to study hydrate behaviour in gas-dominant flows. It operates at high pressure and low temperature conditions, typical of those experienced in deepwater gas fields, where hydrate formation and accumulation may cause blockages with severe consequences.

CSIRO is delivering advanced knowledge of gas hydrate formation and evolution in gas-dominant flows, to improve the design and operation of offshore gas production pipelines.

Layout of the hydrate flow loop.

Research scope

Predictive tools are required to assess the risk of hydrate formation and potential pipeline blockage. The research at CSIRO spans two areas:

1. theoretical modelling of hydrate dynamics within the gas pipeline
2. data collection from experiments to validate and refine the model.

Hytra Loop specifications

The Hytra Loop is a one-pass flow loop in which pressurised gas is continuously circulated. A small amount of liquid is injected at the test section inlet to mimic the water and/or condensate produced with the gas from the reservoir. Hydrates formed in the test section are transported downstream and collected at the outlet with the produced fluids into a two-phase separator. Hydrate formation and transport properties can be studied under conditions that closely simulate gas producing pipelines; low liquid volume fractions and wavy to annular flow regimes.

THE LAYOUT

The loop is 20 m long by 3 m wide with a horizontal test section 40 m in length. The pipe is constructed from stainless steel with an external diameter of one inch. A 'U' by-pass deviation 2 m long and 1 m deep is used to simulate a low point along the pipeline.

'U' bypass for shutdown/startup/hilly seabed simulations.

OPERATING CONDITIONS

The current temperature range of the loop is 4–30°C and the pressure range is 1–110 bar. These specifications allow the loop to operate at conditions well beyond the hydrate onset pressure for most natural gas compositions.

Gas superficial velocities in the range of 5.0–8.5 m/s can be simulated with liquid volume fractions less than 10 per cent.

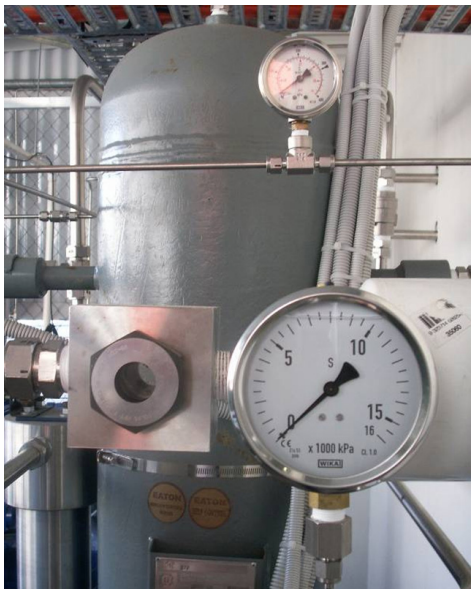
The temperature in the test section is controlled by coolant circulation through a pipe-in-pipe system and heat exchangers regulate the fluid injection temperatures. The flow loop can handle non-corrosive gases, pure water, brines, and model oils with water or oil-soluble additives.

INSTRUMENTATION

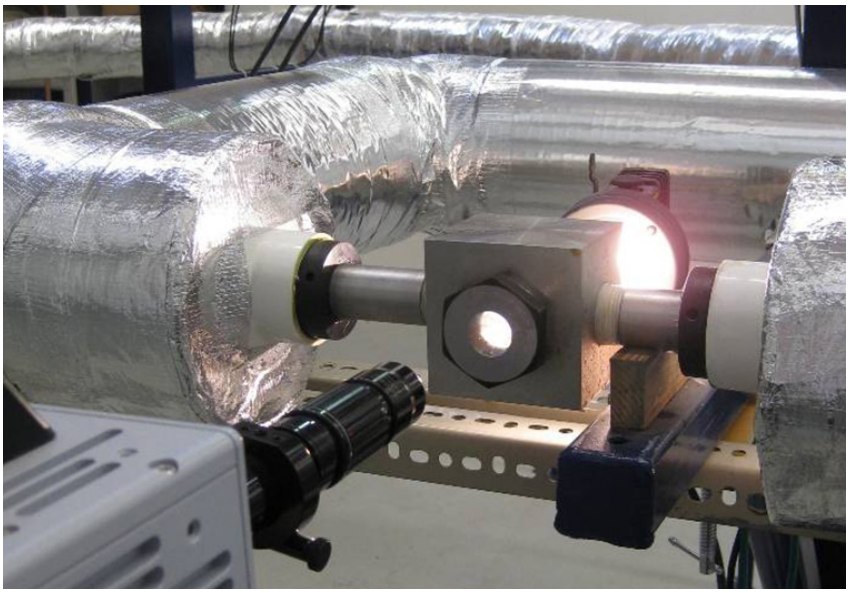
The test section is equipped with pressure transmitters and Resistance Temperature Detector (RTD) sensors to automatically log temperature and pressure readings at seven different locations. Liquid and gas flow meters are also available to measure the flow rates at the flow loop inlet.

The materials inside the pipe can be visually inspected and recorded by high speed video cameras through high pressure visualisation windows at three different locations on the test section.

Data acquisition system.



Separation manifold.



High pressure viewing window and high speed camera.

Applications

The Hytra Loop can be used to study the risk of pipeline plugging under a range of conditions including:

- gas and condensate mixtures
- inhibited and non-inhibited fluids
- low and high sub-cooling temperatures
- continuous flow or restart after shut-down
- topography effects such as low spots.

By understanding the effect of fluid composition, thermodynamic and hydrodynamic conditions on the behaviour of hydrates in pipelines, researchers can develop tools to implement sound risk management strategies for the development of Australia's deep water gas fields.

Our collaborators

Past and current collaborators in our hydrate research program include:

- Institute Francais du Petrole (IFP)
- TOTAL
- Chevron
- BP
- TNO
- Colorado School of Mines
- ANSTO
- Western Australian Energy Research Alliance (WA:ERA)
- Curtin University
- The University of Western Australia

Key contacts

Mr Mauricio Di Lorenzo
Flow Assurance Specialist
Oil, Gas & Fuels
t +61 8 6436 8800
e mauricio.dilorenzo@csiro.au