Title: Challenges in Detecting the Main Causes of Blockage in Flowlines

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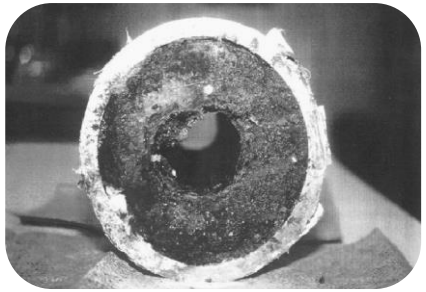
Blockage in Flowlines

- Flow blockage through pipelines and surface facilities is among the most crucial challenges encountered in the oil and gas industry, as well as energy transfer sector.
- A variety of sources cause blockage including gas hydrates, wax deposition, asphaltene deposition, ice, and mineral scales.

Gas Hydrates



Asphaltene

Wax

Ice

Scales

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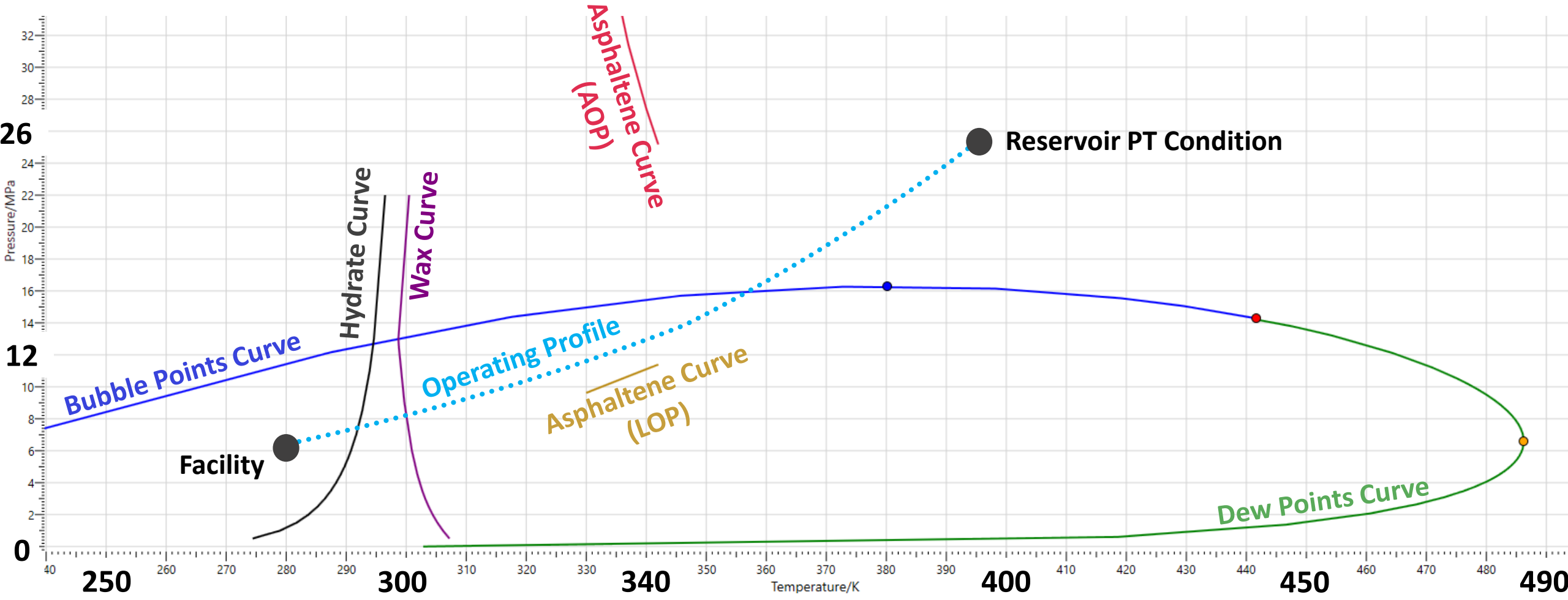
Flow Assurance Study

Phase envelope of crude oil and P-T ranges for flow assurance problems



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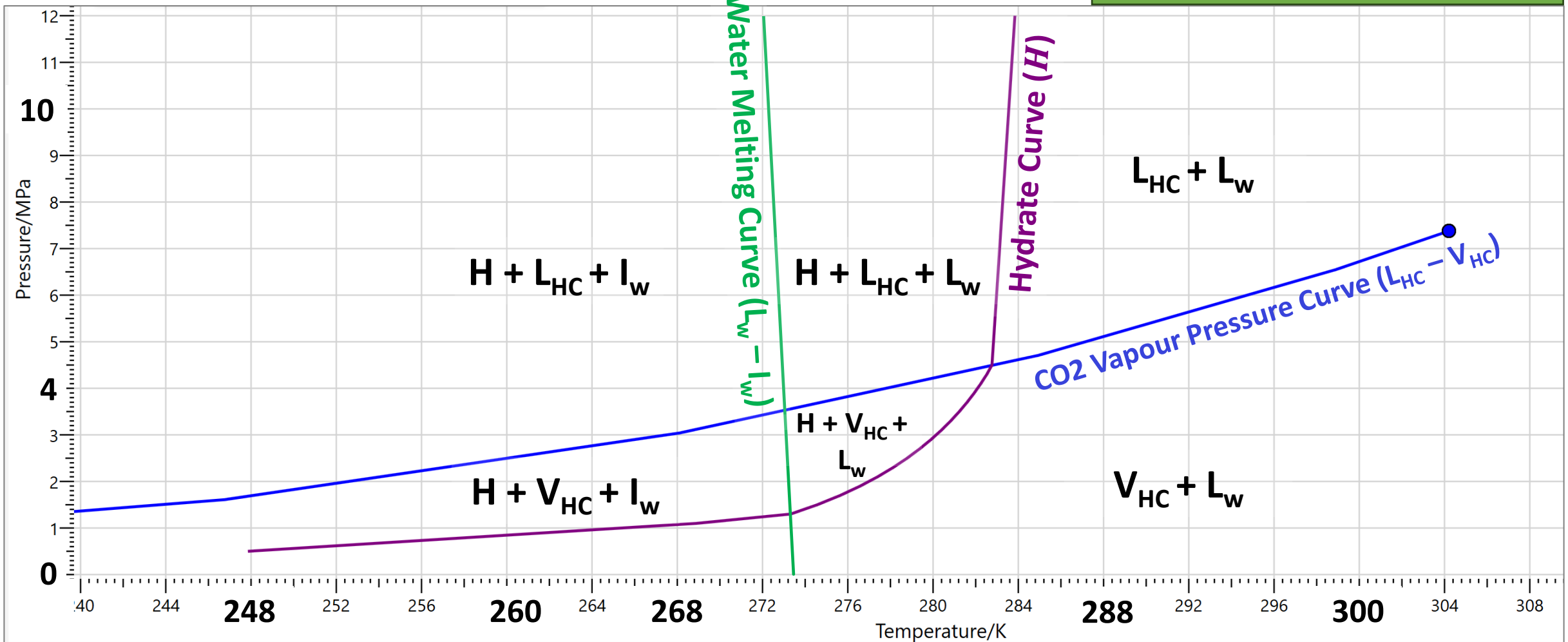
Flow Assurance Study of Gas Hydrates

Detecting the presence of gas hydrates accurately is crucial for effective mitigation. To achieve this, companies must rely on extensive engineering expertise and access to robust thermodynamic models.

Hydrate Phase Envelope for Pure CO_2 in Free Water



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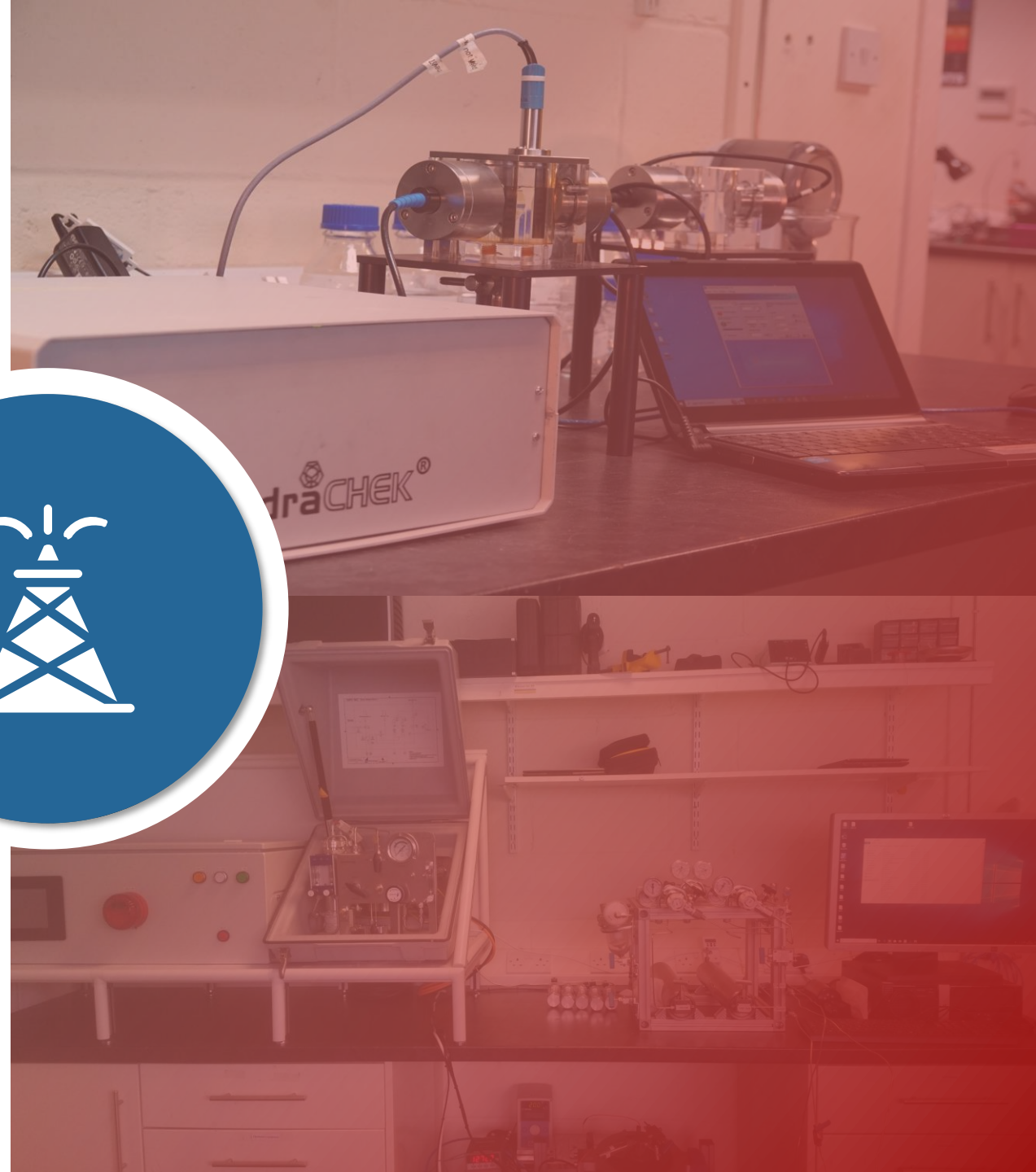
Case Study #1

Suspected Hydrate Blockage in an Underground Pipeline



Case Study #1 - Description

A company approached Hydrafact Limited in late March/early April xxxx with a hydrate blockage problem in one of their underground pipelines.

The pipeline was blocked on 11 February xxxx, after many days of under-inhibiting against hydrates, during a routine pig run.

The company attempted various processes (e.g., **reducing/increasing** pressure). Then, they introduced 8 m^3 methanol from the receiver side on 13 Feb xxxx, followed by 7 m^3 methanol on 17 Feb xxxx on the sender side.

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Case Study #1 - Description

On 23 Feb injected 3,600 SCM N_2 into the receiver side, and on 24 Feb xxxx injected 3,600 SCM N_2 into the sender side to attempt to promote equalization and collect data to try calculating the blockage location.

???? consulted on the blockage and on 3 March xxxx a second pig was sent from the receiver side along with 7 m^3 methanol and pushed with N_2 and reached 861 kPa before stopping to observe.

The surface temperature of subzero at night, and just above zero at daytime.

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Suggested Steps for Mitigating the Problem

No	Initial Proposal
1	Review all the events in chronological order maps and information
2	Plot hydrate phase boundaries for the different fluids
3	Evaluate the risk of hydrate at nights and on days
4	Evaluate the effect N_2 injection and withdrawal
5	Evaluate whether the hydrates are melting
6	Thermal calculations to evaluate the rate of hydrate dissociation
7	Is there any need for N_2 soaking?
8	The best procedure for N_2 soaking
9	The best procedure for melting hydrates and time
10	Possibility of installing a monitoring system

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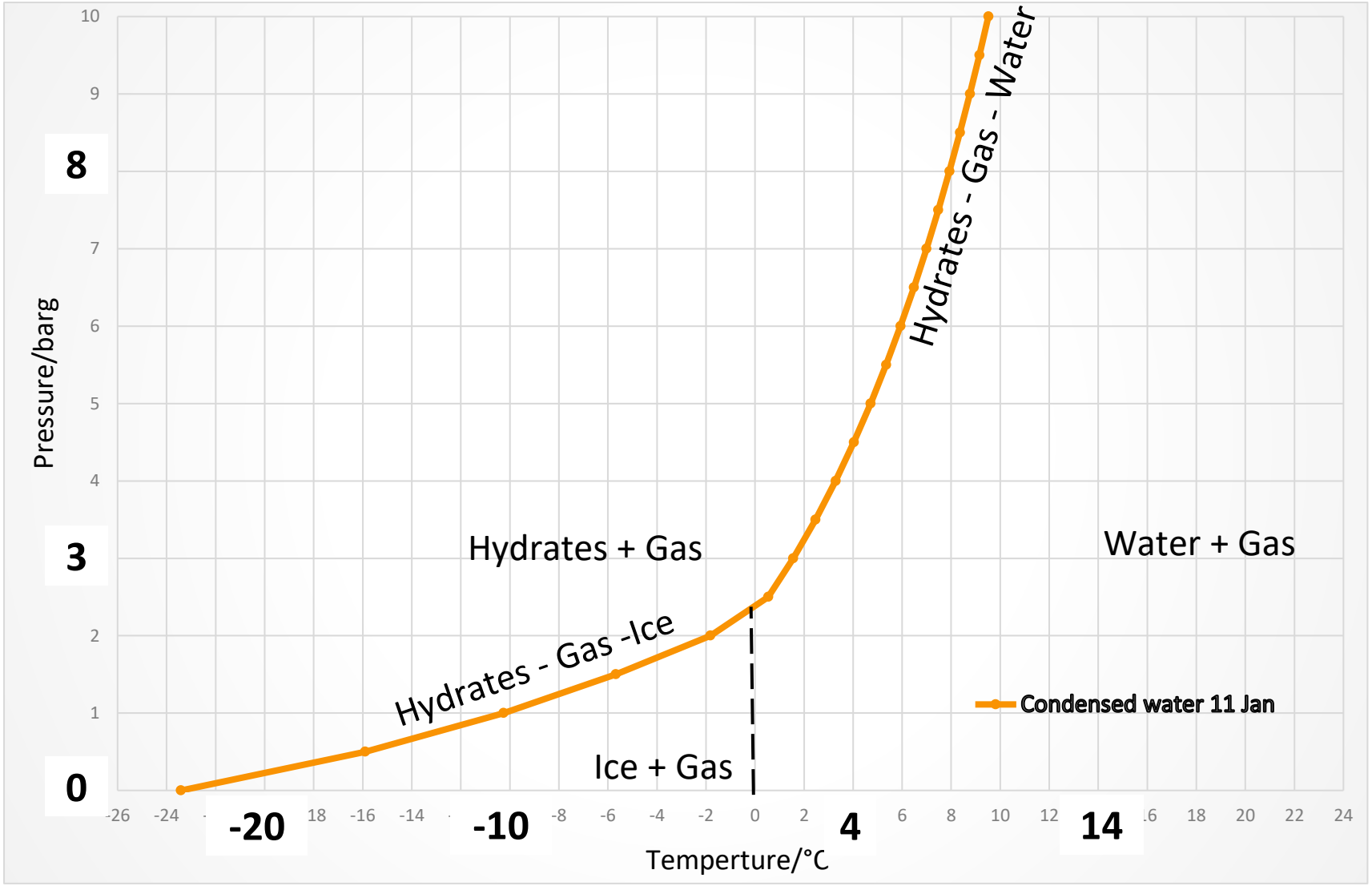
Suggested Steps for Mitigating the Problem

No	Initial Proposal
11	Calculating the amount of water that can come out of gas (i.e., condensed water)
12	Investigating the current inhibitor, i.e., xxxx provided by xxxx
13	Determining where the hydrates start to form and the length of the region that is within the hydrate zone
14	Investigating various options for removing the blockage and their advantages and disadvantages
15	Determining the location of blockage on 7 May xxxx at the end N_2 (with atomized methanol) injection
16	Calculating the position of pigs after pressure drop on 9 May
17	Plan for re-start

Hydrate Phase Boundary



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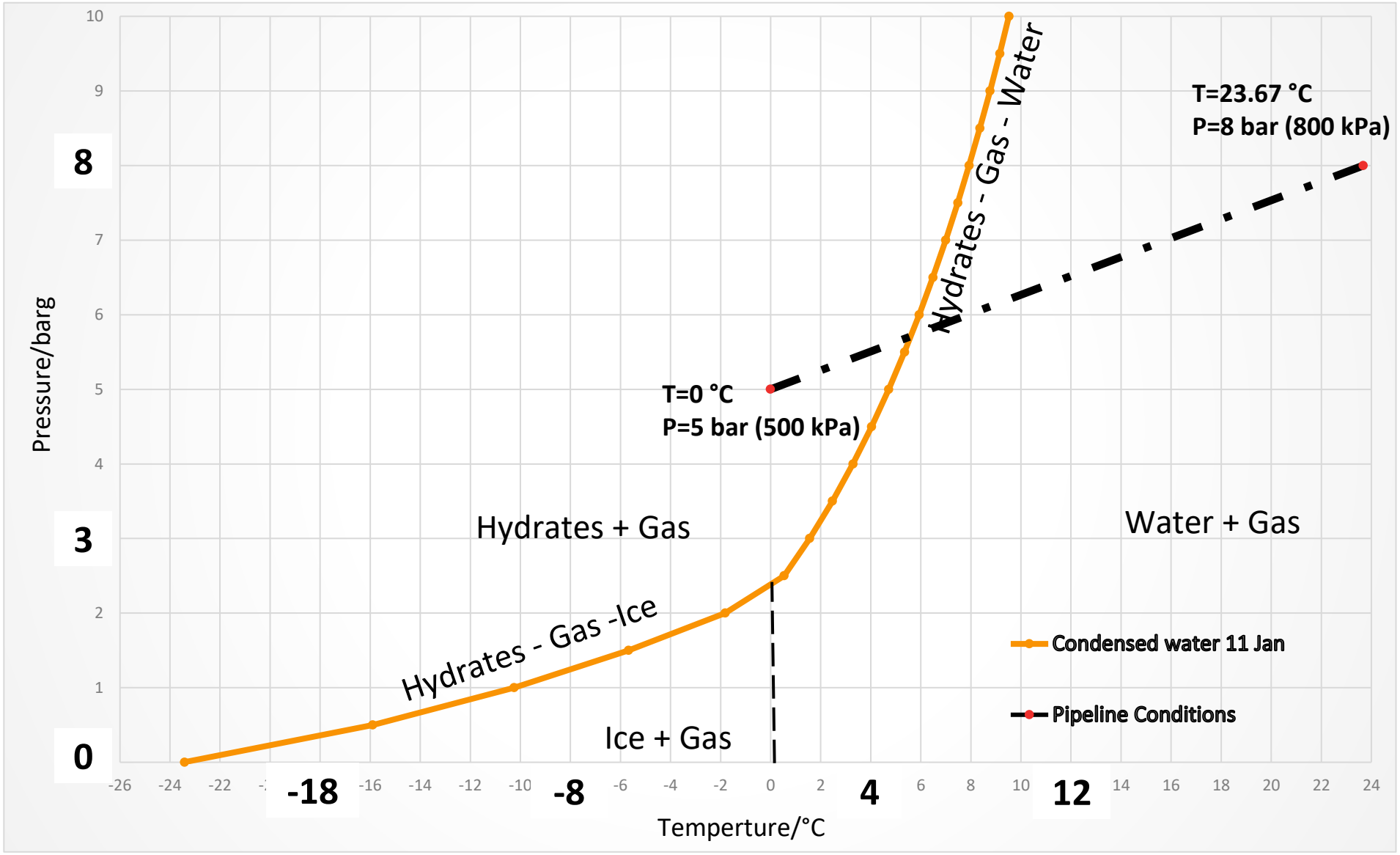
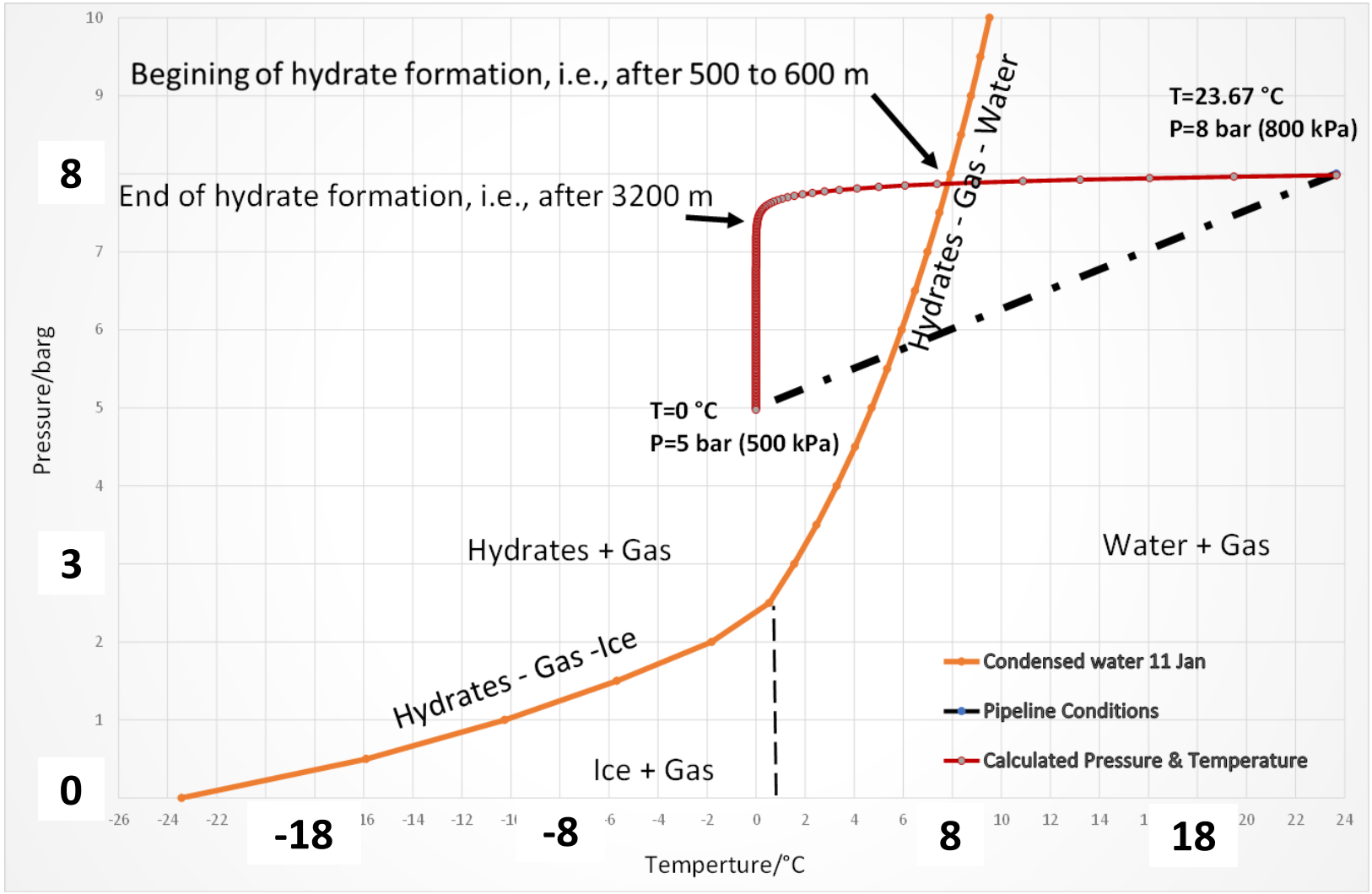
Hydrate Phase Boundary + Flowline PT Curve



Blockage Detection

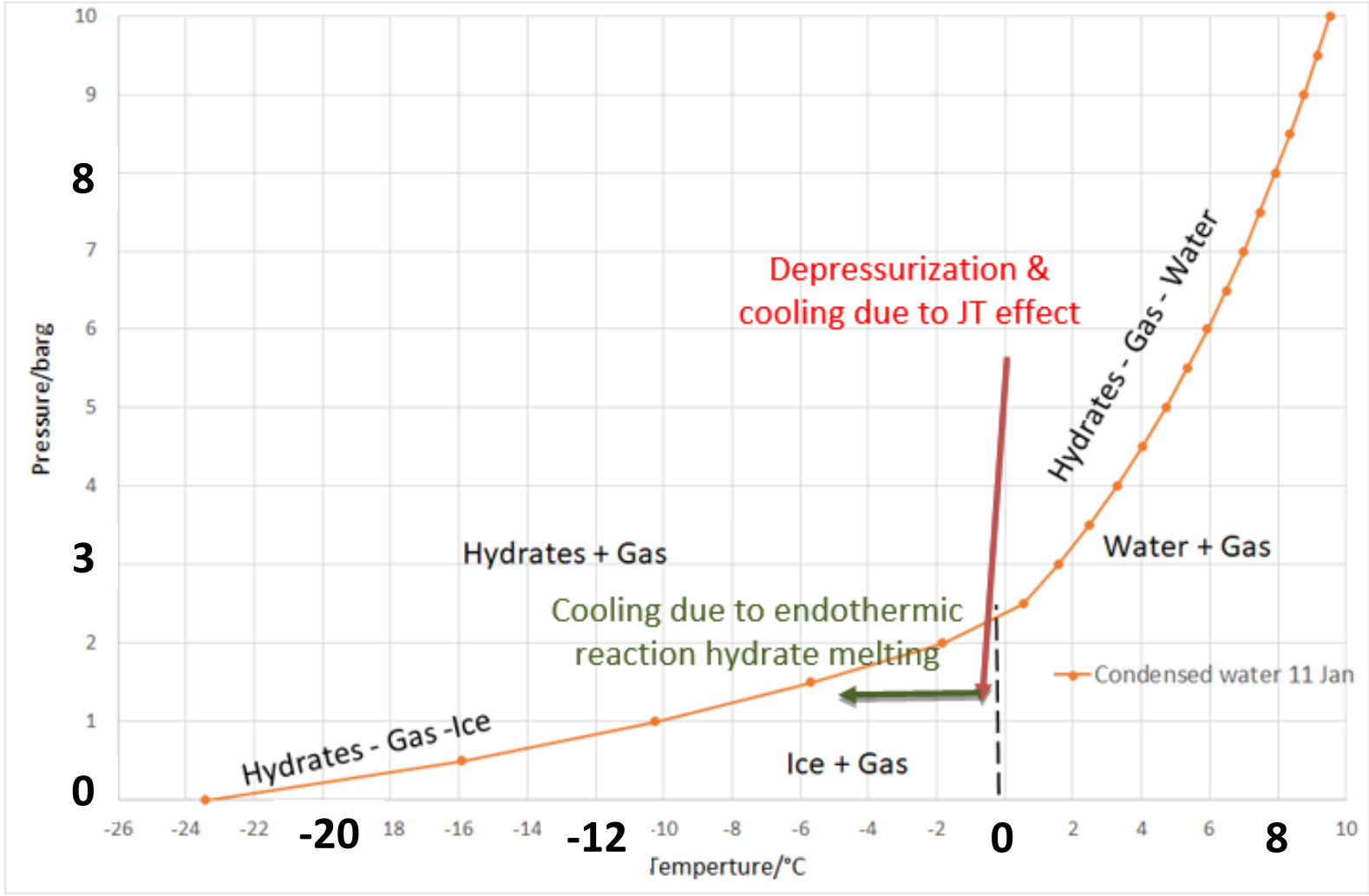
Calculating estimated pipeline pressure and identifying the beginning and end of hydrate formation regions.



Blockage Detection

The company attempted various processes (e.g., **reducing**/**increasing** pressure).

Presence of salt
Methanol
N2



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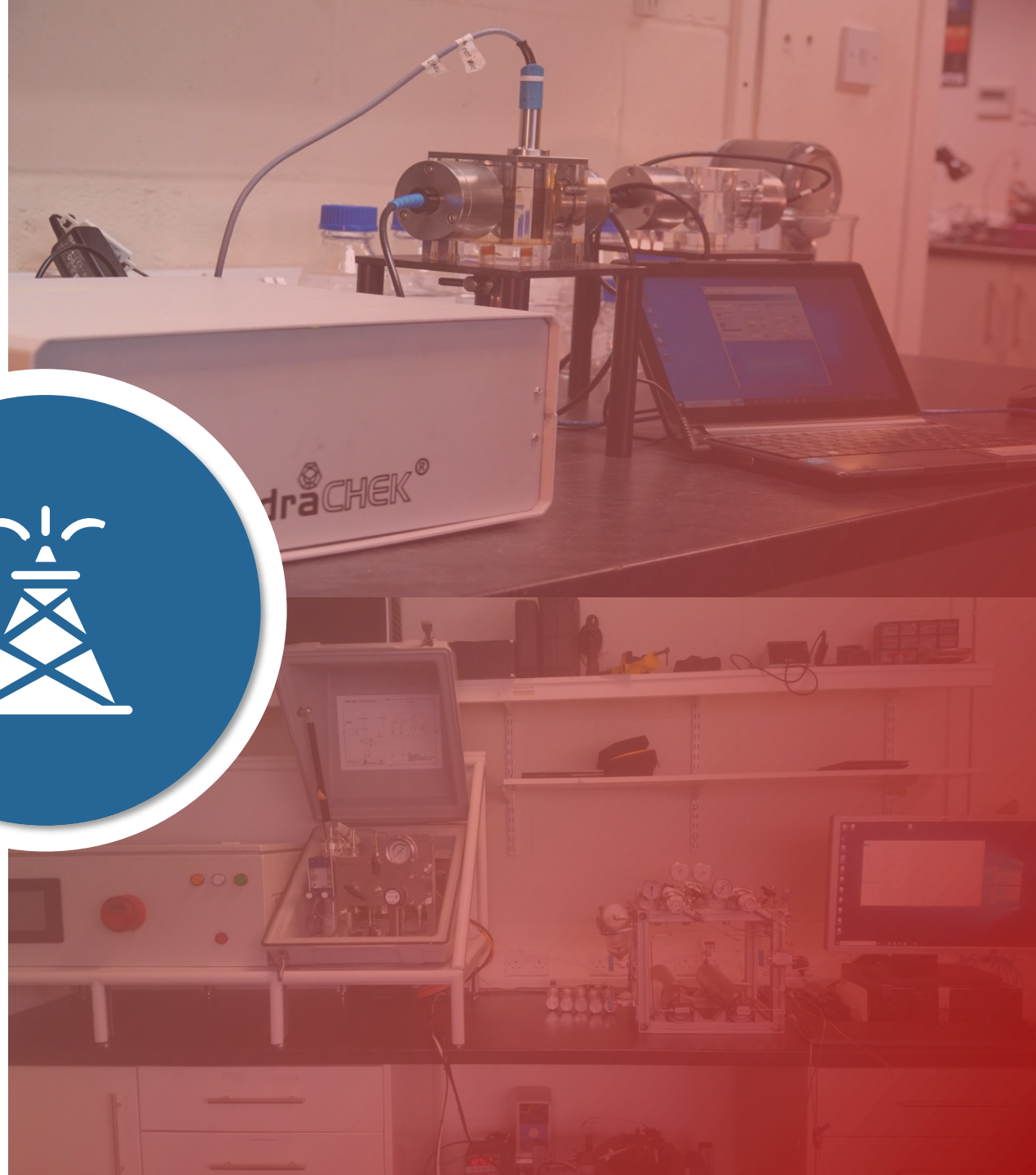
Case Study #2

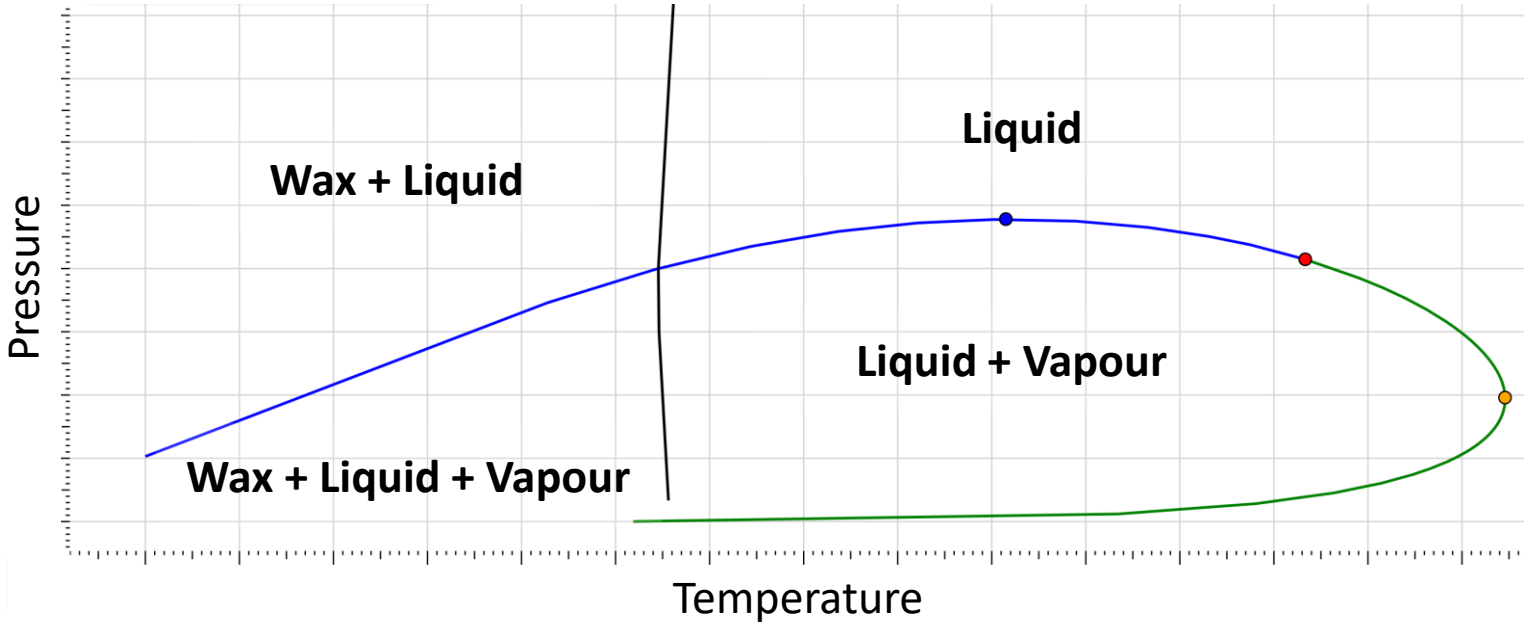
Suspected Hydrate Formation in a Subsea Pipeline

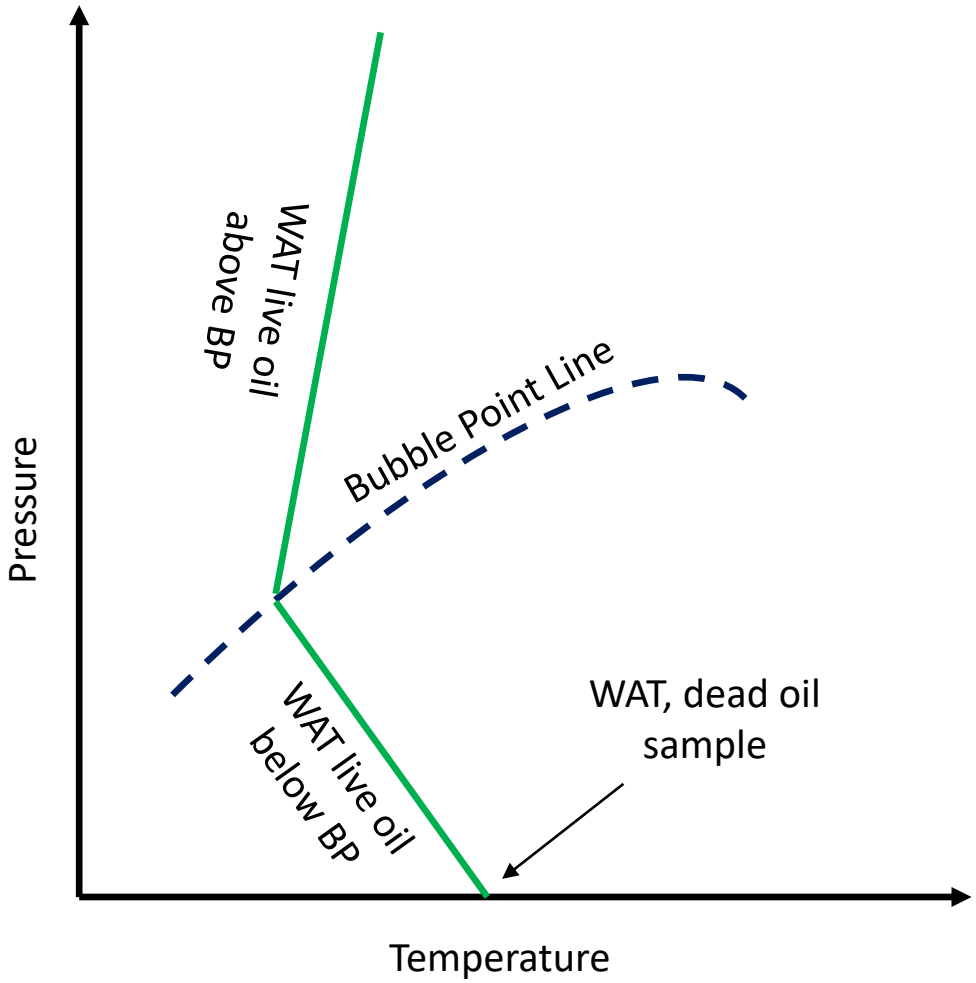


Project Description

- A light oil subsea pipeline was blocked, and the operator assumed it is hydrates.
- They needed Batch Corrosion Inhibitors between two pigs every month (for protecting the top of the pipeline.
- Running the pigs were delayed due to bad weather for 2 month.
- The temperature was 2 ^{o}C lower than normal.
- This was after a reduction of first stage separator to increase the driving force from reservoir to separator.
- Our calculation showed that only hydrate is possible if there is to J-T effect.

Wax Appearance Temperature Curve





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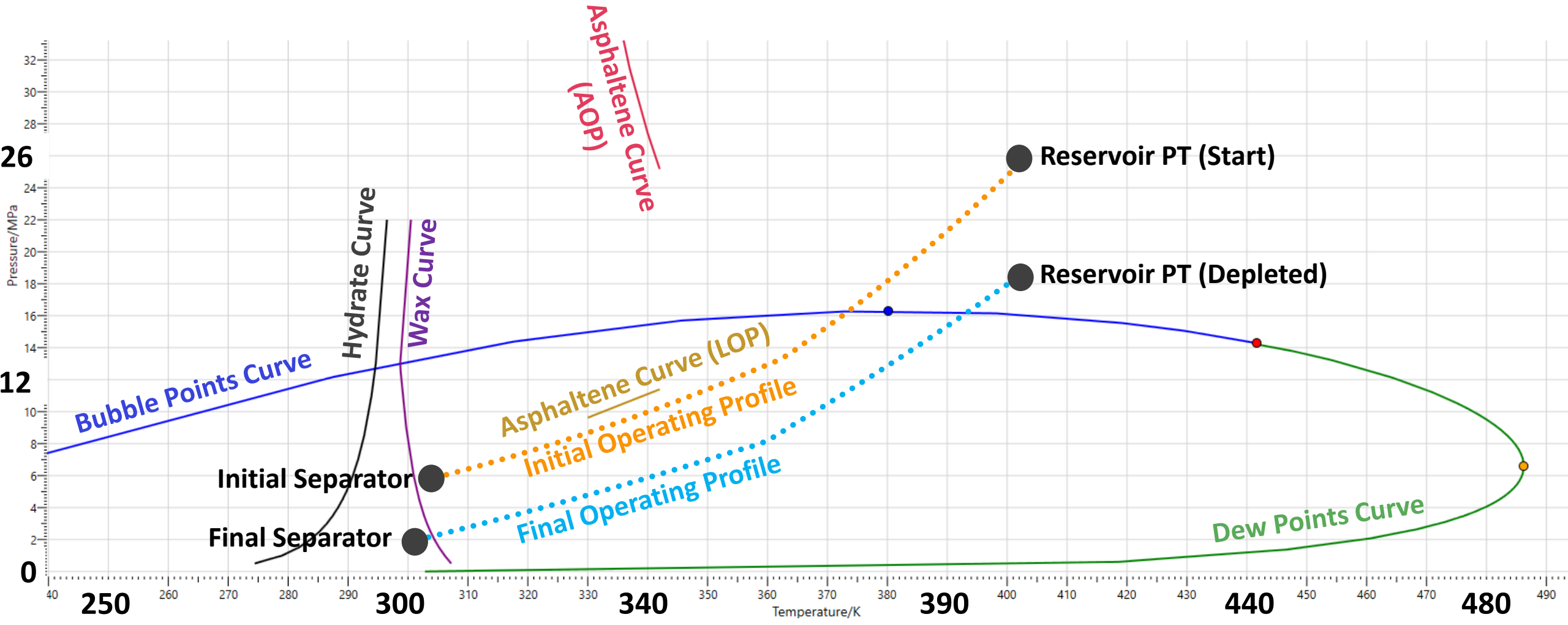
Superimposing Operating Profile on Solid Equilibrium Curves



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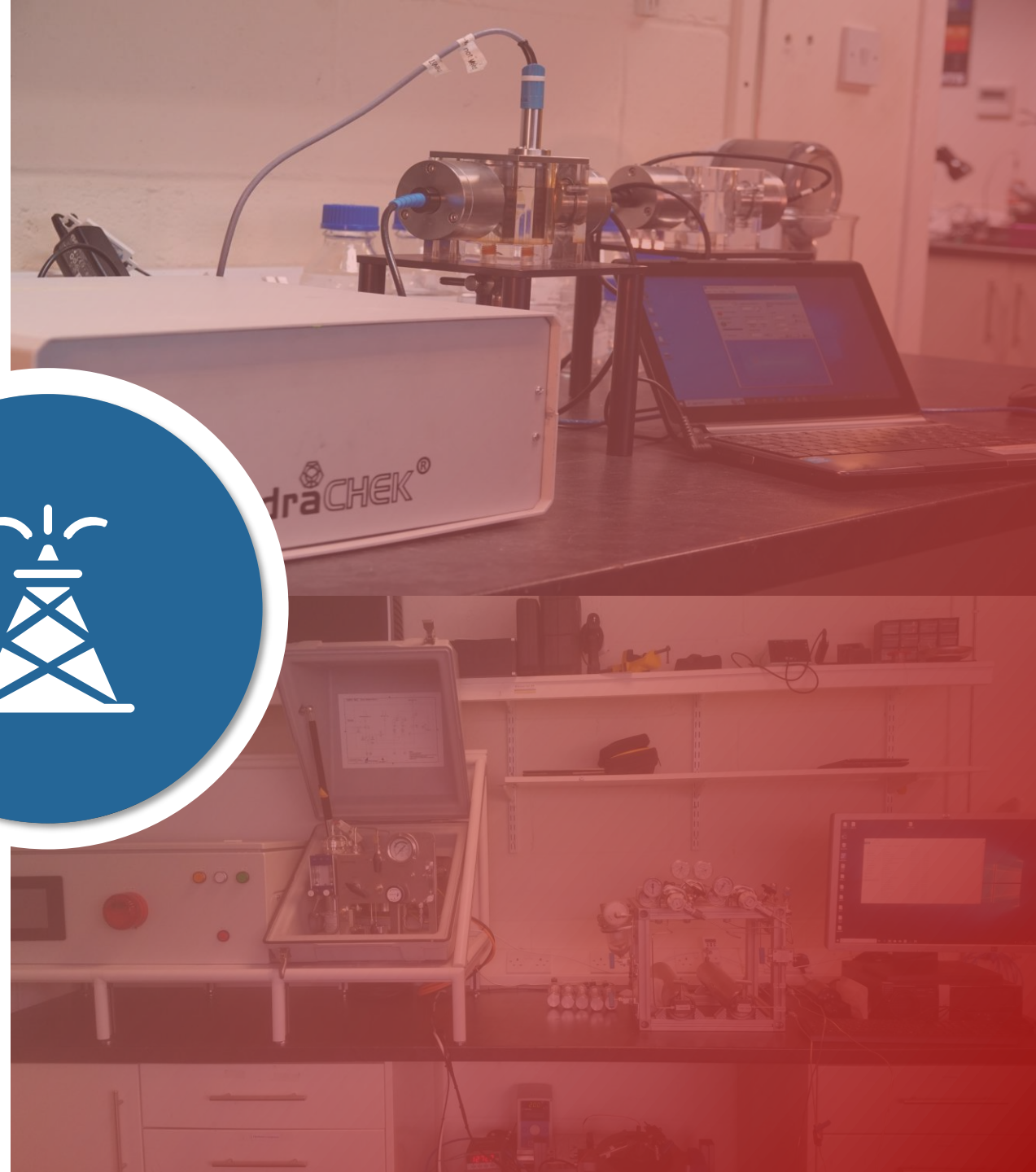
Case Study #3

A Cold Box was blocked, supposedly due to hydrates



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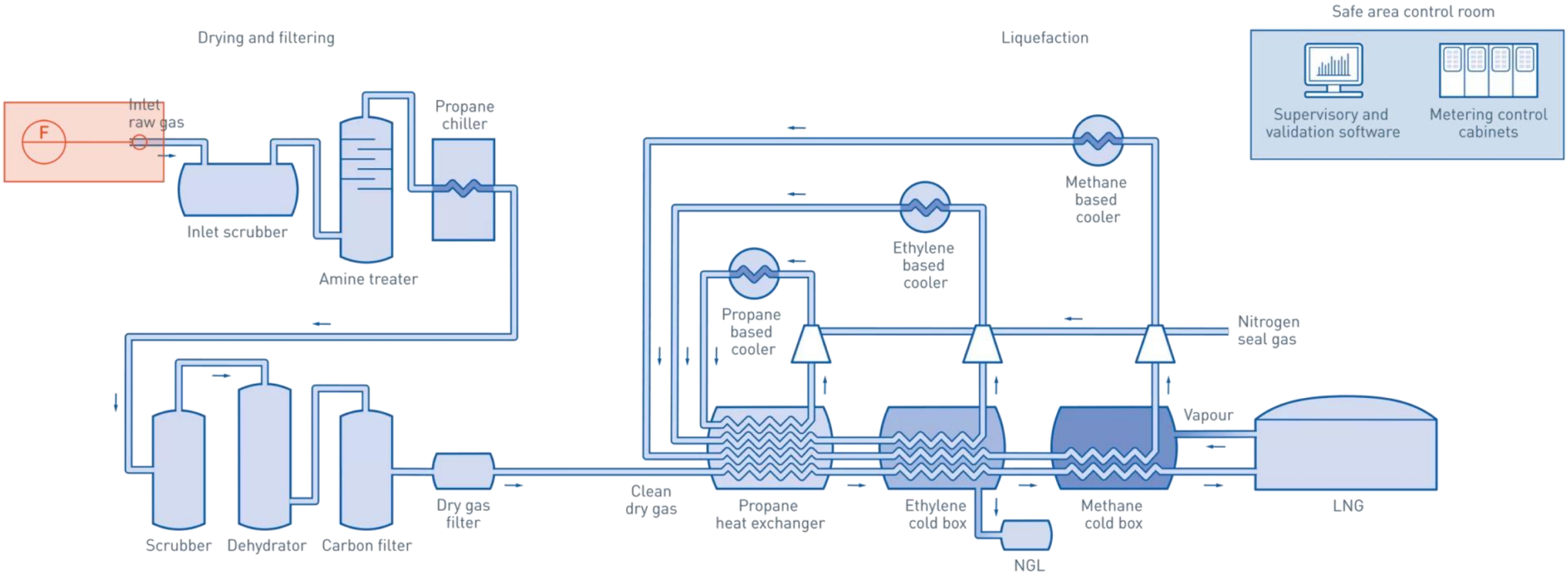
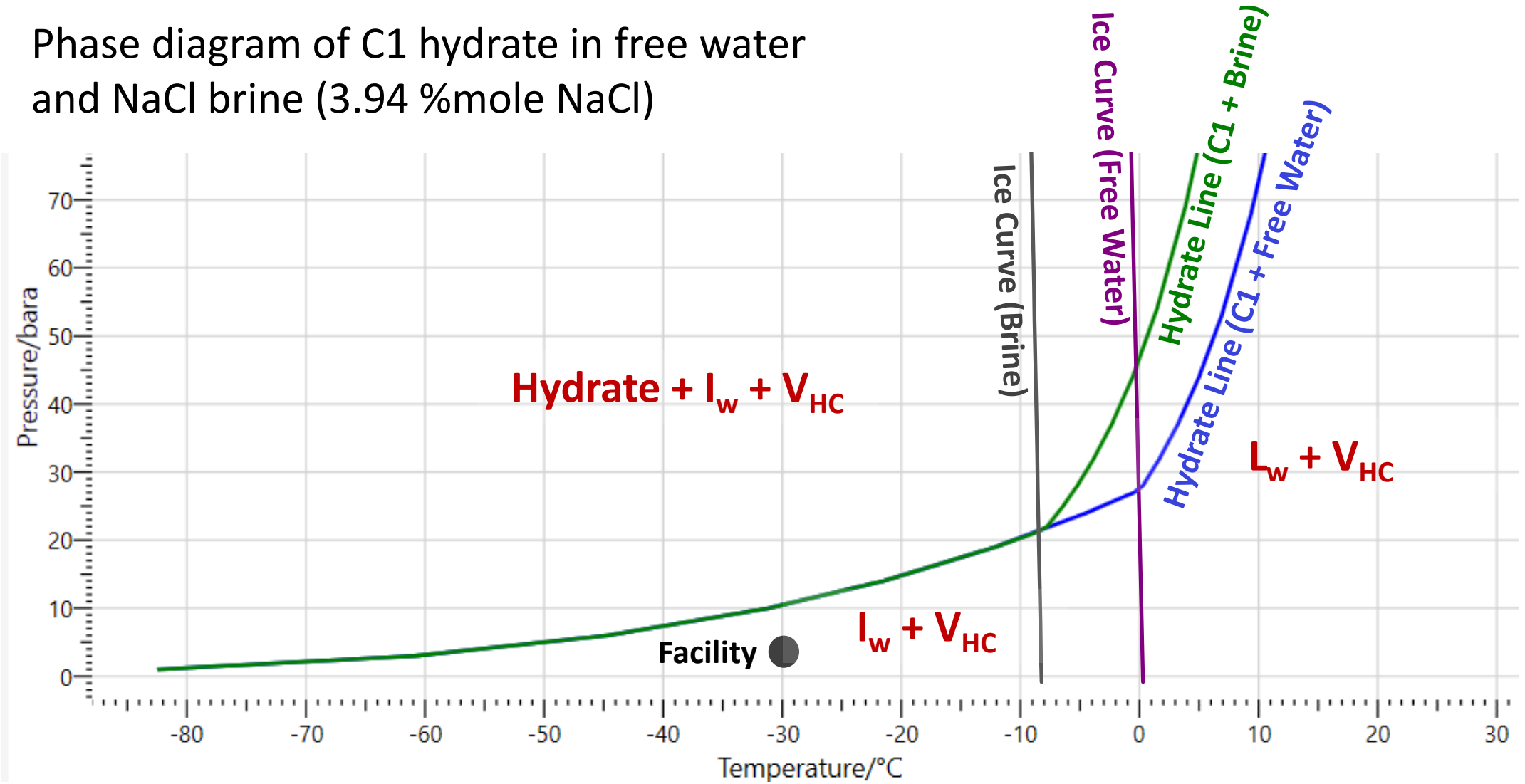
A Cold Box was blocked, supposedly due to hydrates

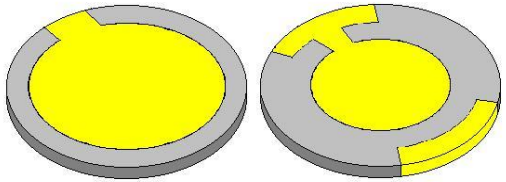


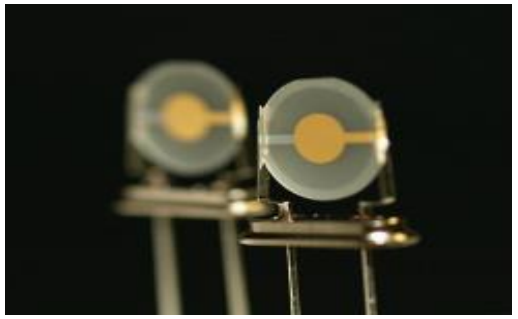
Comparing surface conditions and hydrate equilibrium curves

Phase diagram of C1 hydrate in free water and NaCl brine (3.94 %mole NaCl)

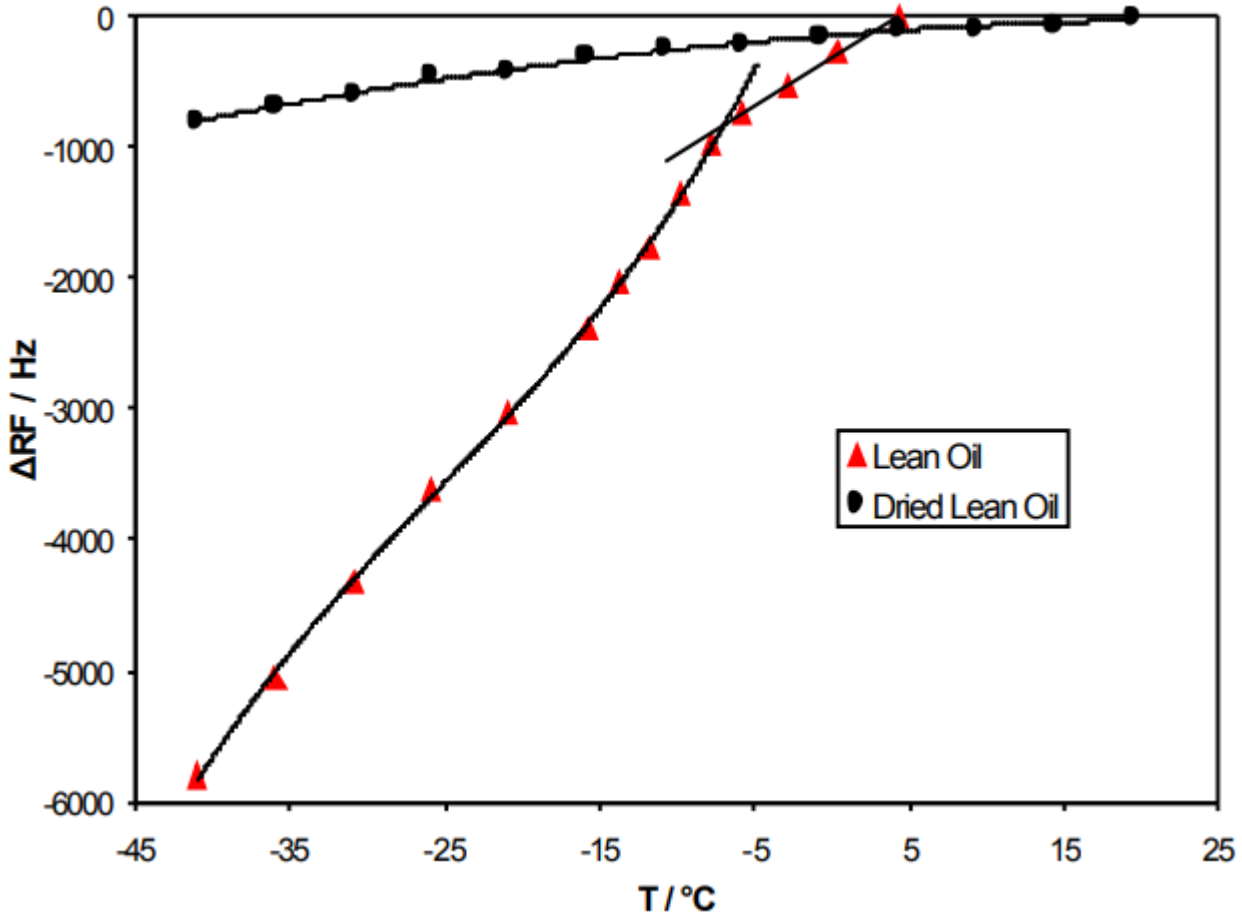


Hydrate, wax, ice and TEG are evaluated by QCM (Quartz Crystal Microbalance) as potential causes for this blockage.





Our Quartz Crystal Microbalance (QCM) can detect 1 μg



Plot of step-heating data for tests with original lean oil sample and lean oil after being contacted with calcium chloride to remove dissolved water.

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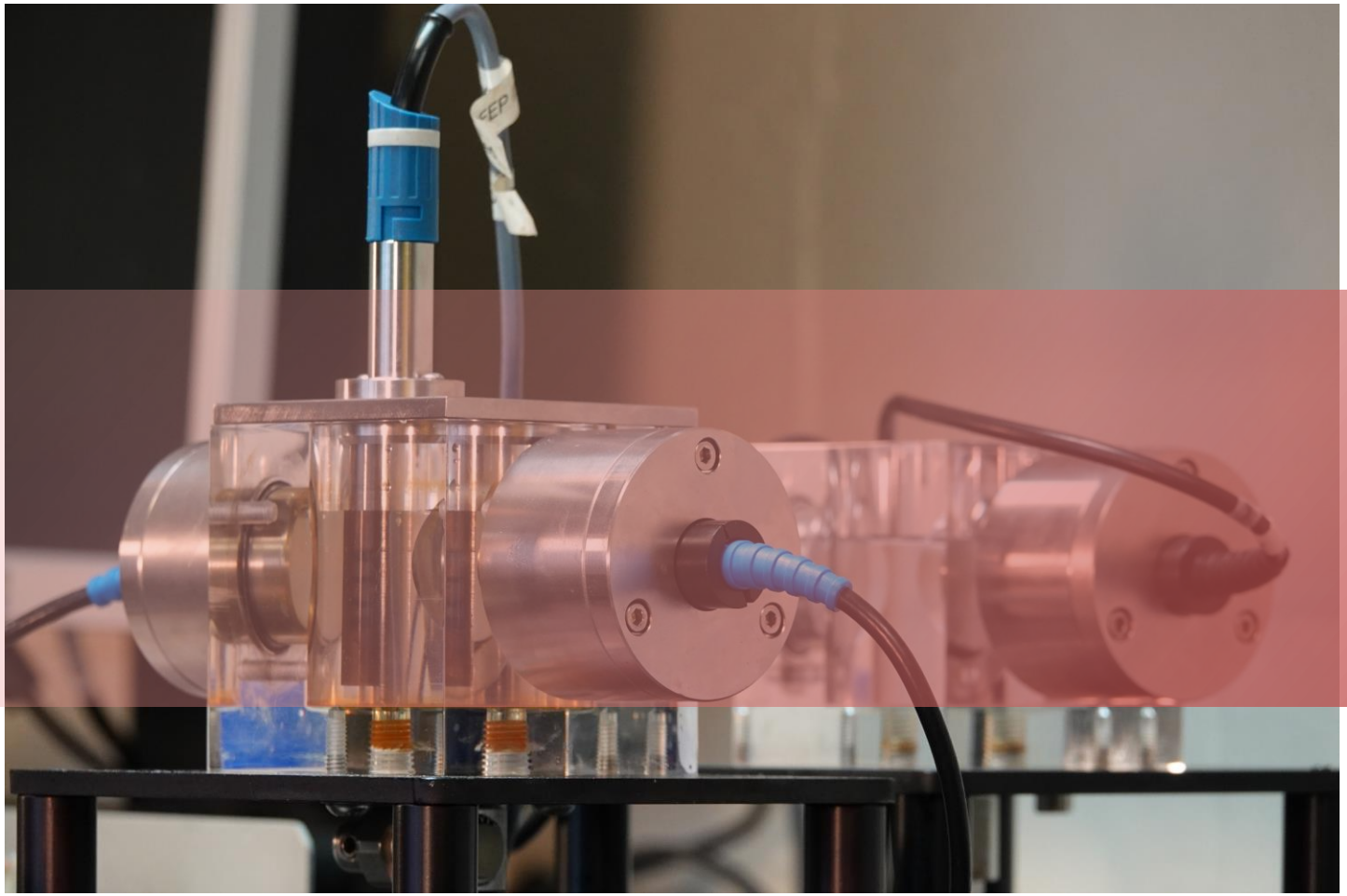

Thanks For Your Attention

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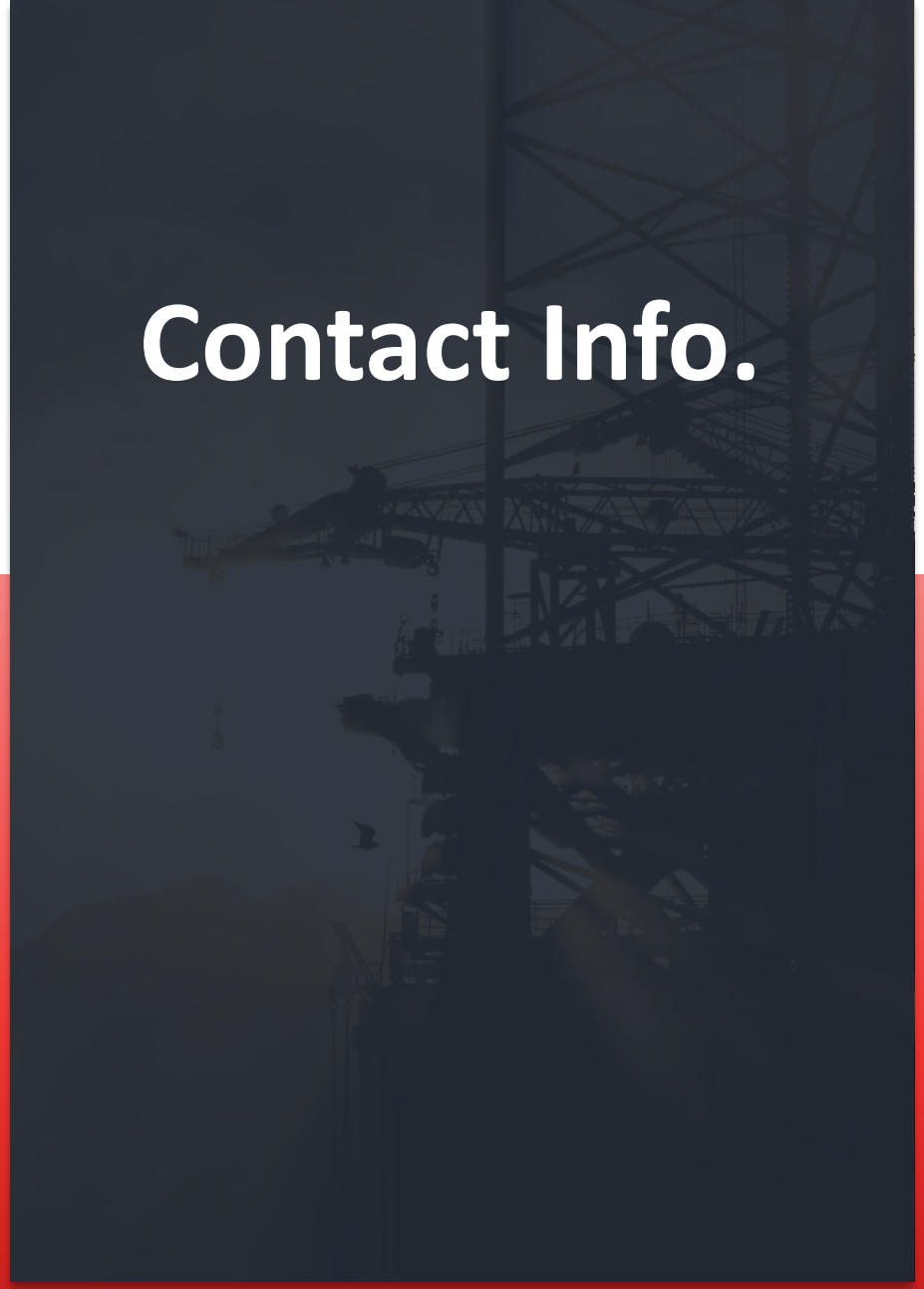
Contact Info.



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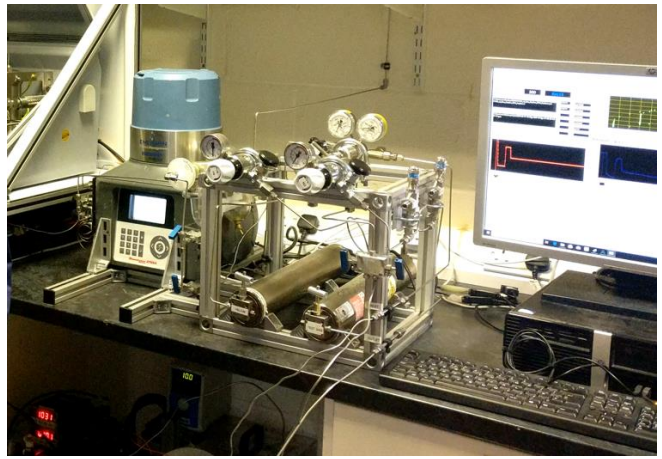

Accurate estimation of hydrate formation initialization and the location of hydrate formation based on compositional analysis.

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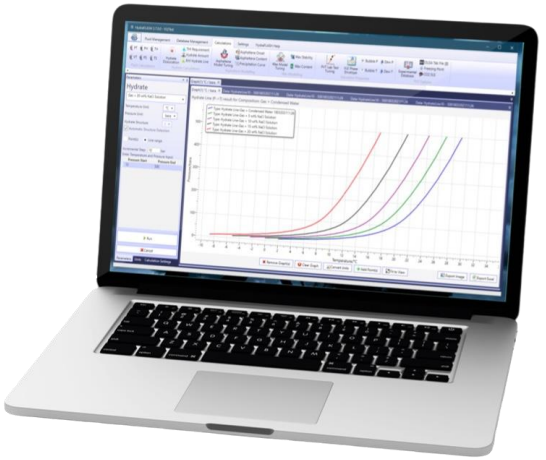

A comprehensive thermodynamic modelling tool for PVT and flow assurance studies, implementing advanced equations of state.