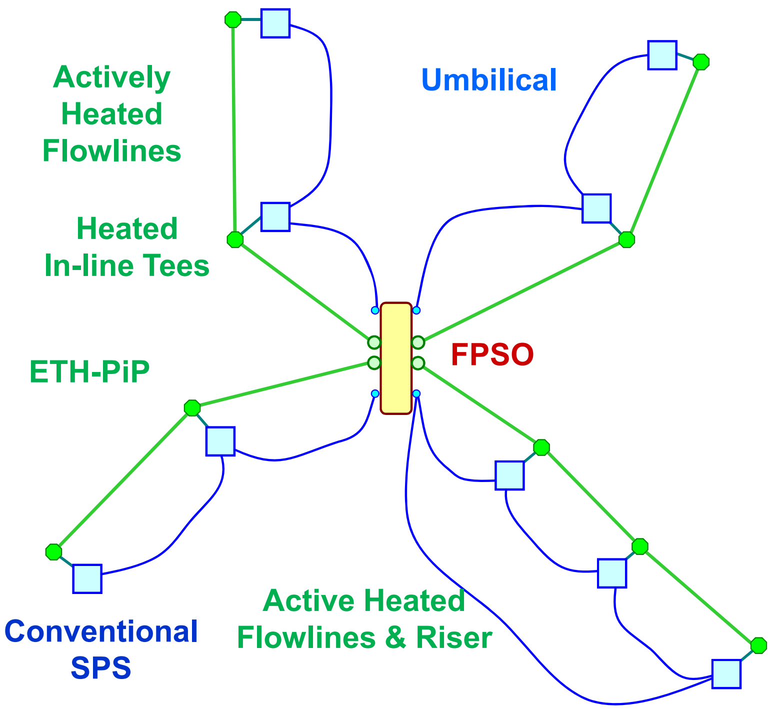
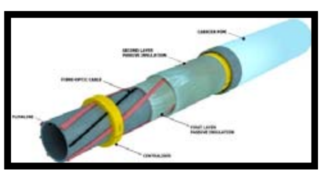
Safe Hydrate Plug Management From Prevention to Remediation

Christina Tzotzi & Antoine Marret
FORSYS Subsea, Paris

Benefits in Simplified Architectures based on Continuous or Occasional Heating





Single Line Benefits:

- **50% less flowlines length**
  - **Less Procurement & Installation Costs**
- **50% less risers**
- **Reduced size of chemical umbilical's & maniforlds**
- **Minimize number of spools & PLETs**

25% CAPEX Savings

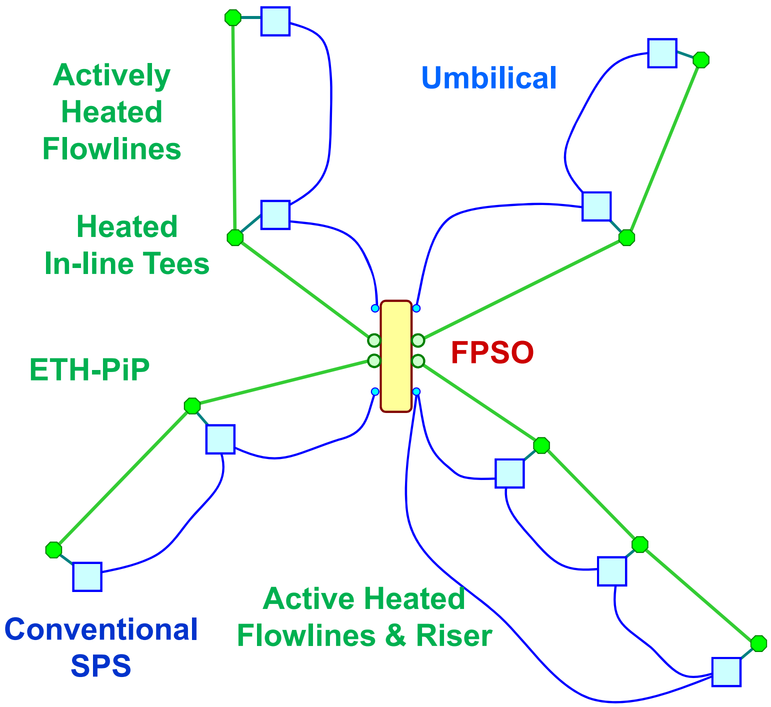
CAPEX/ OPEX trade off:

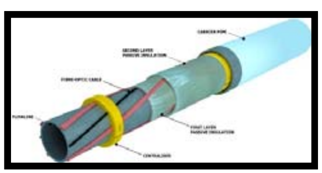
- **Lower insulation level by continuous heating**

On most projects, only short periods of production necessitate high passive insulation

More Insulation CAPEX | **Less Heating OPEX** | **Vs.** | **Less Insulation CAPEX** | **More Heating OPEX**

Benefits in Simplified Architectures based on Continuous or Occasional Heating



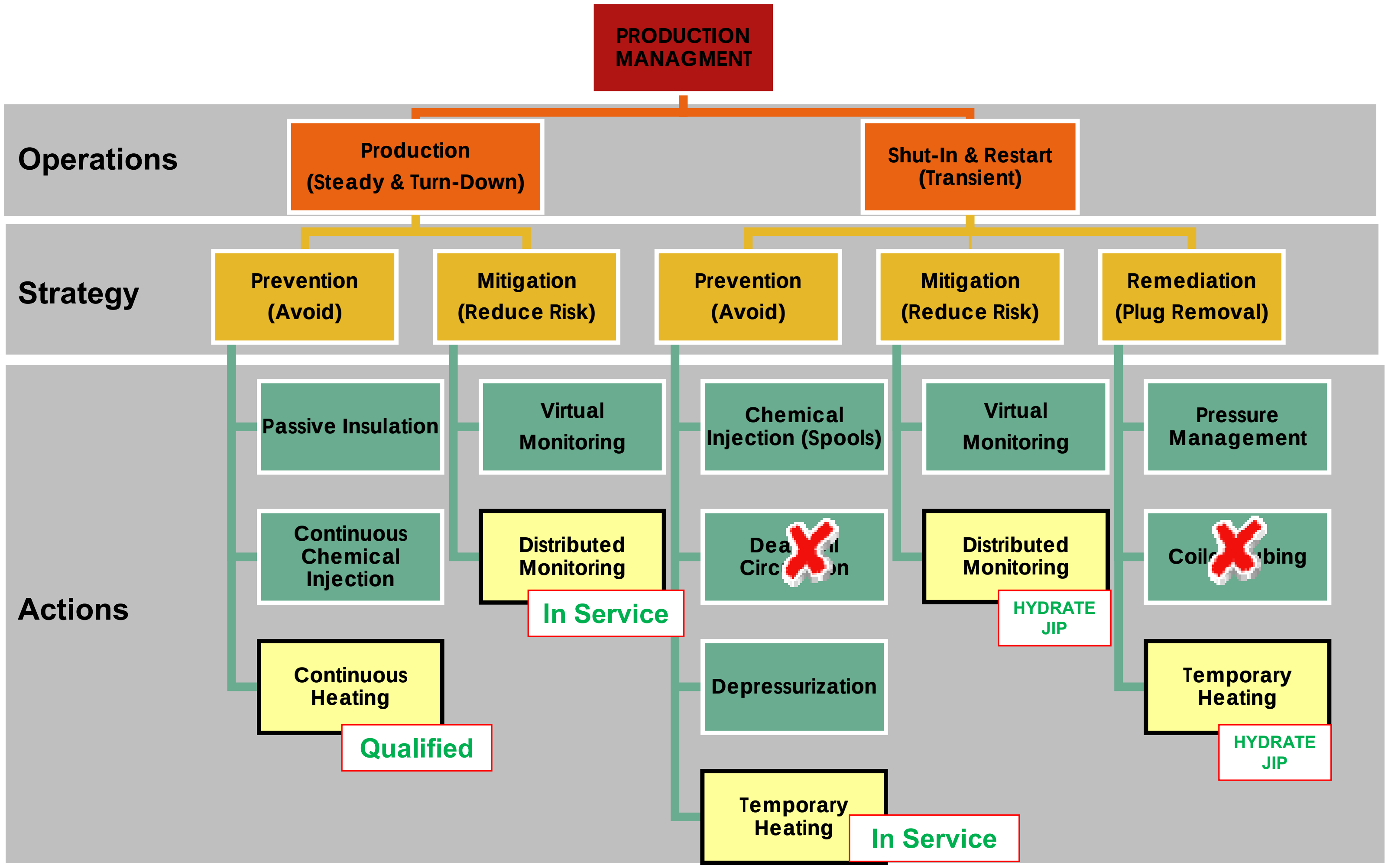


Active Heating Benefits in Operations

- **Shorter shutdown duration (no touch time): Faster & Easier shut-down and restart**
- **Wax Management: No need for frequent pigging**
- **Reduced amount of injected chemicals**
- **Addresses most of flow assurance issues during life of field**
- **Potential IOR benefits (lower dP at the end of field-life enabled by continuous heating**

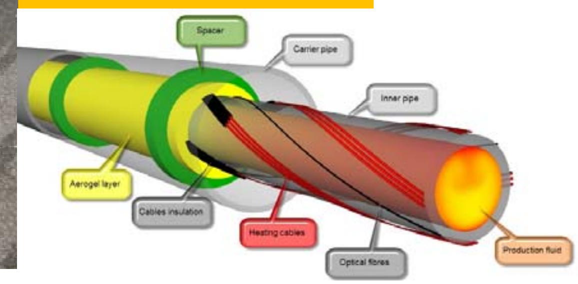
Resulting in OPEX savings

Hydrate Management in Simplified Architectures



JIP : Safe Hydrate Plug Management in Active Heating Flowlines

ID = 6” (eq. to Islay ETH-PIP)
U_{ID} = 1 W/m2.K
Length = 18 meters
Hydrate Quantity > 200 kg
Max Pressure = 110 Bar
Max ΔP across plug = 30bar



Partners :

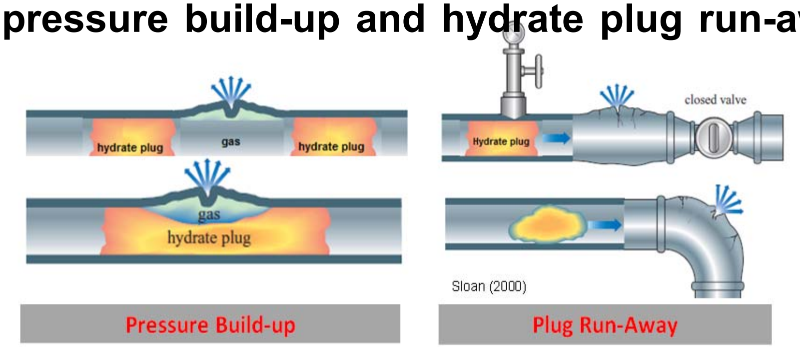
ExxonMobil
Technip
TOTAL
woodside
ifp Energies nouvelles

JIP Objectives

- **Plug Quality:** **Produce low-permeability and low-porosity hydrate** plug.

- **Full Scale Experiments:** **Experiment ETH technologies for safe dissociation of hydrate plug and eliminate the risks for local pressure build-up and hydrate plug run-away by careful control of heating input.**

Risks



- **Modeling:** **Validate simulation tools based on CFD for subsea structures and develop an 'in-house' 2D for hydrate remediation subsea field applications.**

- **Monitoring:** **Qualify a monitoring system based on DTS for Hydrate Plug Condition Monitoring : Formation, Dissociation by Depressurization &/or Active Heating.**

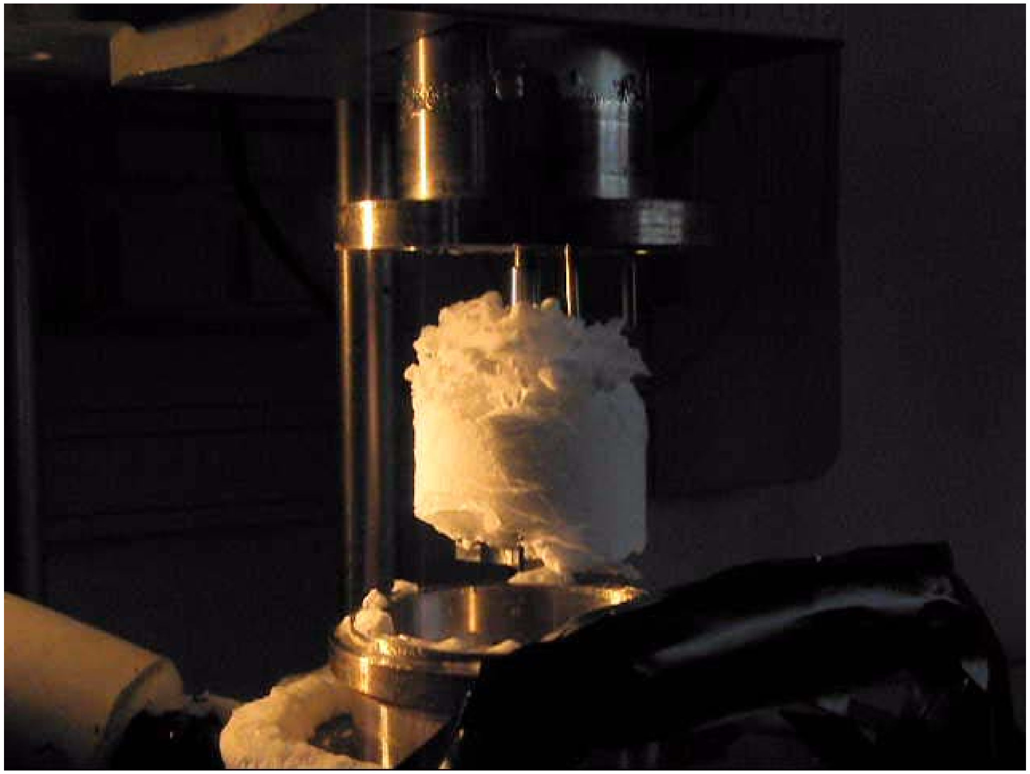
JIP Achievements

Plug Quality

Experiments

Modeling

Monitoring



Target: Form the hardest plug that corresponds to the worst subsea conditions

- Plug permeability in the range of mDa.
- 35 bar Pressure Differential across the plug
- Large conversion rate from 60% to 95%.
- 200 kg of hydrates plug formed
- 16.5 m long

JIP Achievements

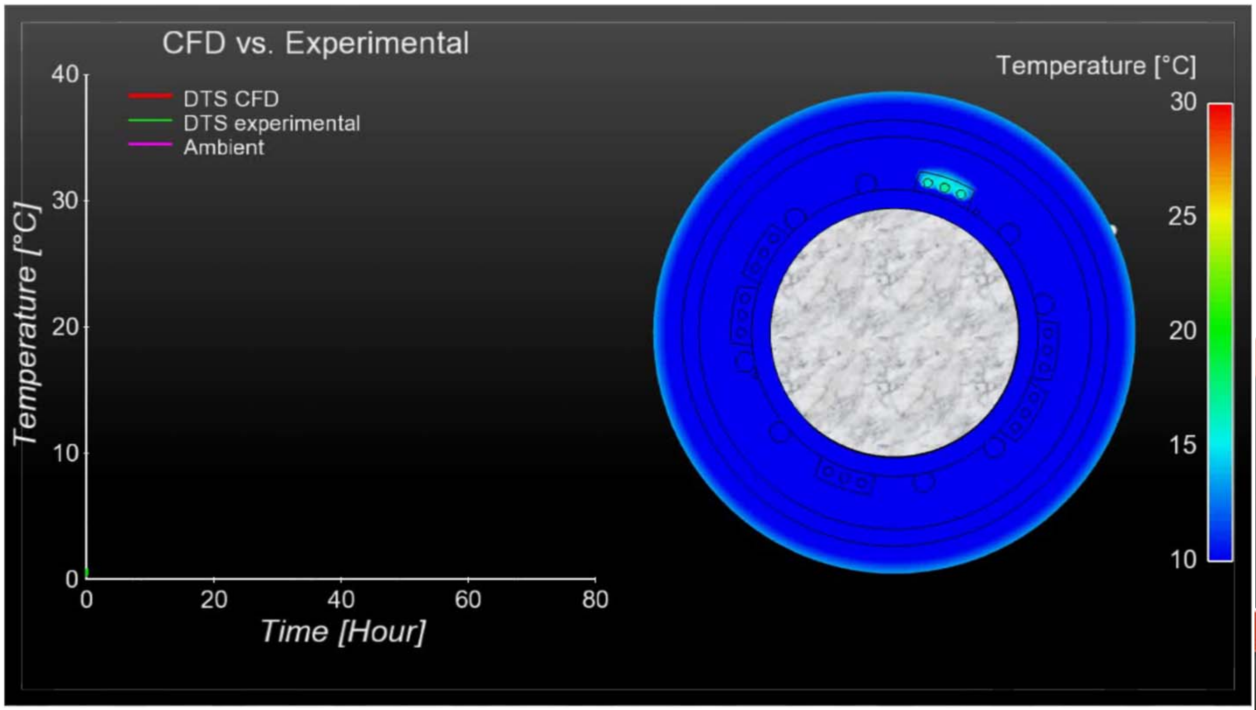
- Plug Quality
- Experiments
- Modeling
- Monitoring

Test Number	Dissociation Scenario	Status
Phase 1 – 1	Base Case	√
Phase 1 – 2	Sensitivity on Plug Length	√
Phase 1 – 3	Sensitivity on ETH Power	√
Phase 1 – 4	Sensitivity on Number ETH Cable "In Use"	√
Phase 2 – 1	Sensitivity on High ΔP across the plug	√
Phase 2 – 2	Sensitivity on Dissociation in a Closed Volume	√
Phase 2 – 3	Sensitivity on DEH Heating Conditions	√
Phase 2 – 4	Sensitivity on Presence of Oil in Hydrate Pores	√
Phase 2 – 5	Sensitivity on Hydrate Structures	√

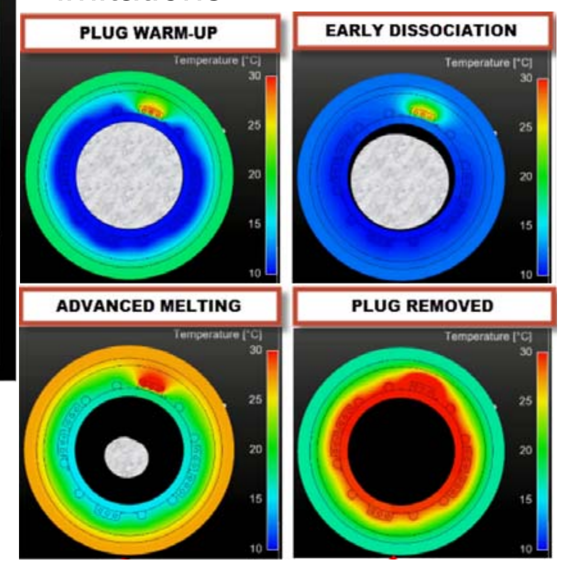
Extensive 3 year experimental campaign covering the most severe cases subsea for defining safe operating conditions

JIP Achievements

- Plug Quality
- Experiments
- Modeling
- Monitoring



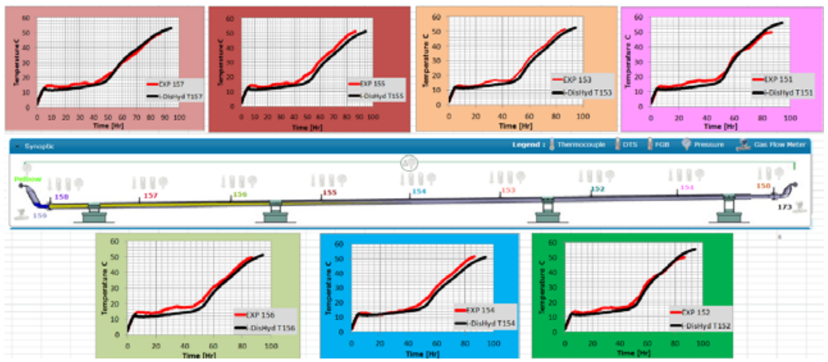
- JIP data are used for the development and the validation of 2D/3D In-House CFD Model.
- Identification of model's limitations



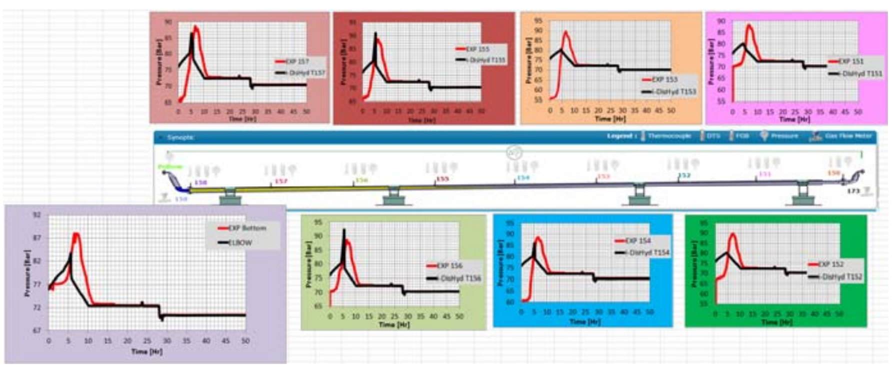
JIP Achievements

- Plug Quality
- Experiments
- Modeling
- Monitoring

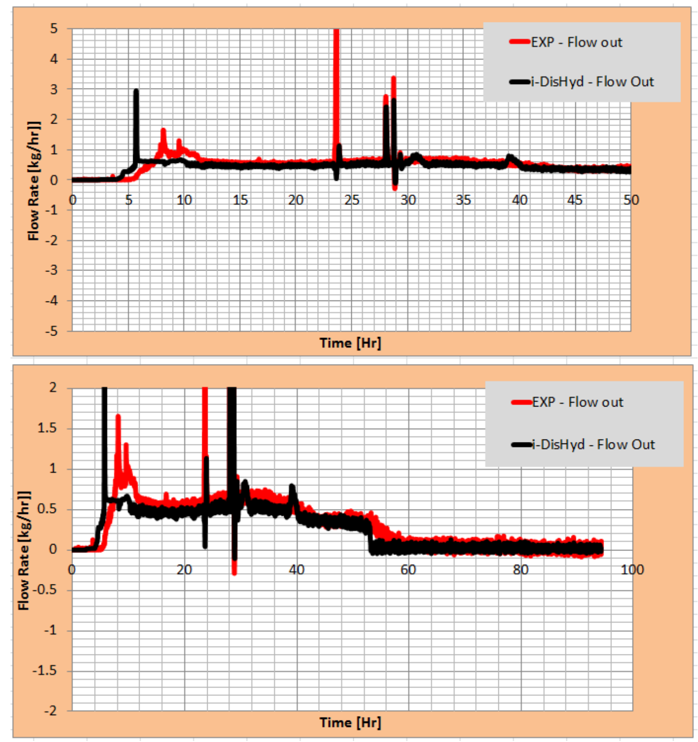
- Development of i-DisHyd™ for simulation of Subsea Operations with regard to Hydrate Plug Detection, Dissociation and Formation.



Validation against **Temperature Data**



Validation against **Pressure Data**



Validation against **Gas Flow Rate Data**

JIP Achievements

Plug Quality

Experiments

Modeling

Monitoring

- **Demonstrated capacity to interpret live DTS Data**
  - Hydrate Localisation
  - Plug In Dissociation – Yes / No.
  - Local Pressure Behavior – Increasing / Constant.
  - Has Plug Completely Melted – Yes / No.

Next Steps: ETH Blanket development

Develop a heated blanket for subsea flowlines, quick and asset light flow assurance intervention.

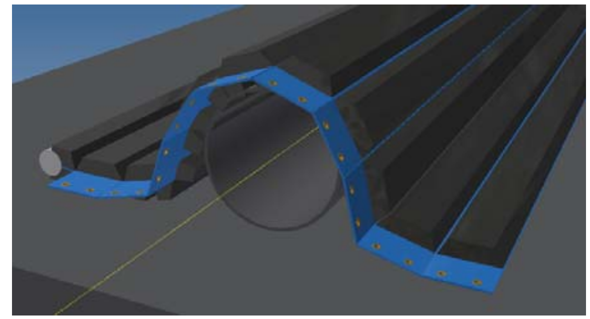
Short-Term application:

⟶ Detect & remove Hydrate/Wax/Gelling accidental plugs for Brownfield

New JIP Proposal

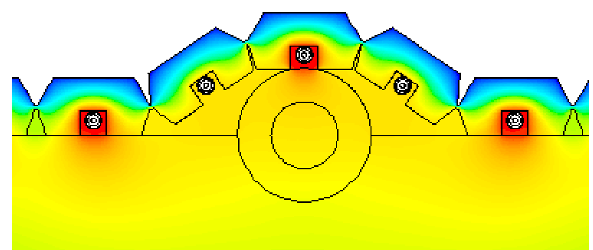
Longer-Term application:

⟶ Risk Based Flow Assurance for Greenfield = CAPEX optimized design (single, wet-insulated lines) thanks to OPEX capabilities.



As an intervention kit, the ETH Blanket will allow to :

- **Solve Hydrate Plugging** issues in a complete, faster and cheaper manner compared to depressurization method or coiled tubing;
- **Safely remediate Hydrate plugs** with no risk of excessive pressure build-up or plug run-away
- **Solving Wax Plugging** in existing flowlines due to mis-operation or pigging;
- **Decrease cold-restart pressure** required to break gel plug → increase safety aspects



Combination of 2 New Technology Building Blocks to meet new field development challenges

New Active Heating Technologies for safer Hydrate Risk Management, lower CAPEX, better Operability and lower OPEX

- Efficient Building blocks for :
  - Greenfield : architecture simplification
  - Brownfield : long tie-backs / difficult reservoirs
- Can be efficiently combined with Subsea Processing and Topsides Optimization
- Can allow more flexible and cost effective operations including continuous integrity monitoring and new robust hydrate / wax management philosophies
- Retrofit capabilities (ETH Blanket) should assist in the development of a risk based flow assurance approach
- However, their potential benefits should be assessed at conceptual stage

Thank you for your attention!

Christina Tzotzi, Ph.D.
Study Manager – Business Integration & Planning Department
christina.tzotzi@forsys-subsea.com

FORSYS SUBSEA