Hydrate management – How to cut down cost

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Current hydrate management strategy

• Production outside the hydrate zone

• Requirements
  • Thermal insulation
  • Massive injection of THI* (MeOH or MEG)
  • Heating devices e.g. Electrical
  • Complex operating procedures e.g. Dead oil preservation

*:THI = Thermodynamic Hydrate Inhibitor
AA-LDHI: a way to produce inside the hydrate zone

• AA-LDHI: Anti-Agglomerant Low Dose Hydrate Inhibitor
  • Injection dose: ~ 1% / hydrate phase to be compared with ~ 50% / water phase for THI*

• Formation of a slurry of fine hydrate particles dispersed in the suspending liquid phase (no agglomeration, no deposit formation)

• Limitation in terms of slurry viscosity

\[ \mu = \mu_L \left( \frac{1 - \phi_{hyd}}{\frac{1 - \phi_{hyd}}{\phi_M}} \right)^2 ; \quad \phi_{hyd} < \phi_M \approx 60\% \]

*:THI = Thermodynamic Hydrate Inhibitor

\[ \mu = \mu_L \left( \frac{1 - \phi_{hyd}}{\frac{1 - \phi_{hyd}}{\phi_M}} \right)^2 \]
Development of an in-house simulator

• A predictive tool to handle formation and flow of hydrate slurries
• Main hypotheses
  • Steady state 2-phase flow conditions
  • Thermodynamic equilibrium (no kinetics – conservative approach)
  • Compositional calculation
  • Slurry viscosity = viscosity of a dispersed suspension
  • Exothermicity of hydrate formation considered in thermal calculations
Development of an in-house simulator

• Example
  • single liquid flow with a condensate saturated with gas at 150 bar and at WC=20%
Application to subsea gas fields

• New architecture concept for gas field developments
  • 1x6” pipe for MEG transport → AA-LDHI in existing umbilical (~1 bbl/d)
  • MEG regeneration unit at onshore

• Additional possible cutting CAPEX
  • Lower liquid content → lower hydrodynamic turndown
  • 2 production lines → 1 production line

Cutting CAPEX ~ 400 M$
Application to subsea gas fields: Operational envelop

- Only condensed water is considered
  - All the water phase is transformed into hydrate
  - No salt
- Key point: WC at the entrance of the hydrate zone
- CGR is the main relevant parameter for hydrate transportability
- CGR threshold: ~ 4 – 10 SMm^3/Sm^3
  - Can vary depending on the pressure in the line
  - Might be higher in case of production of reservoir water
Application to satellite subsea oil fields

• Production line + service line → ETH*-PiP + Subsea systems + all elec.

Adapted from L. Riviere MCEDD Pau 2016

*:ETH = Electrical Trace Heating
Application to satellite subsea oil fields

• Another gain step can be reached by replacing the 12”/18” ETH-PiP by 14” wet insulated pipe
  • CAPEX 80% → CAPEX 62% \(\text{(according to L. Riviere MCEDD Pau 2016)}\)

• Batch injection of AA-LDHI for degraded flow conditions and planned shutdowns (makes feasible subsea storage)

• Risk of hydrate formation during long unplanned shutdowns and restarts
  • Depressurization at the SSU*: may be not enough
  • Continuous injection of AA-LDHI for unplanned shutdowns management might result in high OPEX

* SSU = Subsea Separation Unit
Application to satellite subsea oil fields

- A case-by-case risk assessment is required by considering:
  - Maximum quantity of hydrate that can form
    - Thermodynamic conditions
    - Limited by GOR and salinity of produced water
  - Actual quantity of hydrate that can form
    - Kinetics effect
  - Natural AA properties of the oil
    - May enable to drastically reduce the quantity of AA-LDHI be continuously injected
Conclusions

• Subsea gas fields
  • Large cutting CAPEX by replacing MEG with AA-LDHI
  • Can be applied to low CGR cases

• Satellite subsea oil fields
  • In addition to the simplified ‘single line’ architecture, AA-LDHI can offer an another significant cutting CAPEX.
  • Batch injection of AA-LDHI to manage degraded conditions and planned shutdowns
  • A case-by-case risk assessment is required for long unplanned shutdowns
    • Continuous injection of AA-LDHI may be lead to high OPEX
    • Should depend on oil properties
THANK YOU FOR LISTENING

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BACK-UP
CGR and WC definitions

- Pseudo-process considered to calculate CGR and WC:

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Application to satellite subsea oil fields

• ETH-PiP → wet insulated line + continuous AA-LDHI injection

Adapted from L. Riviere MCEDD Pau 2016