USE OF MEG AND LDHI - PROOF OF CONCEPT

NEW JIP PROPOSAL - 2023/2024

HYDRATE INHIBITION ON GAS FIELDS AND CARBON FOOTPRINT

RESPONSIBLE OIL AND GAS

At the present time, gas supply - especially in Europe- is a key economical and geopolitical question and must be conjugated with the environmental concerns

- The hydrate management on deep offshore/offshore gas fields or offshore /onshore plant's long tiebacks …is crucial to insure **gas production**
- MEG loops are a "solution of choice" to ***safely*** produce these gas fields, operating these loops require huge energy demand
- Two questions arose then
  - What is the carbon footprint to ensure these productions, and can it be decreased?
  - Can CAPEX/OPEX be minimized for such developments?

Are the use of MEG + LDHI a viable way to reach these goals?

COUPLING THE USE OF MEG AND LDHI*

RESPONSIBLE OIL AND GAS

*LDHI = KHI: Kinetics Hydrate Inhibitor or AA: Anti-Agglomerant

Industrial context

- Benefits for MEG + KHI:
  - **Reduce de carbon footprint related to MEG loops**
  - hydrate inhibition for high water-cuts without increasing MEG injection flow rates [1] - **Extend the operating time of a field**
  - **Maintain the gas production and ensure hydrate inhibition** of a line if available MEG flow rates are too low [2]
  - **Reduce MEG injections utilities/ MEG regeneration/reclaiming units**
- Benefits for MEG + AA
  - **Reduce de carbon footprint related to MEG loops**
  - **Ensure the reliability of AA solutions for very low liquid hold up lines** (possible Hydrates deposits at the Top of Line)
  - **Reduce MEG injections utilities/ MEG regeneration/reclaiming units**

[1] Extending operating life with AA-MEG synergetic inhibition; UWA- Petrophase 2019
[2] Hydrate plug formation risk with varying watercut and inhibitor concentrations, Sohn et al., Chemical Engineering Science, 2015

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- Current operational Barriers:
  - Flow Assurance: reliability of the scenario (hydrate formation/deposition/transportability, restart conditions after a shutdown, hydrate dissociation)
  - Impact of chemicals on water quality after water/oil separation
  - Impact of chemicals on MEG regeneration/reclaiming process
  - Environmental hazardous / products regulation
  - Additives compatibility

- Scientific barriers
  - Optimal dosage of chemicals for efficiency
    - Ideal LDHI dosage in presence of a under-inhibited MEG system
    - Chemical additives partitioning between phases (aqueous, HC, liquid and gas)
  - Crystallization
    - Formation kinetics (hydrates, salts…) and maximum conversion rates in multiphase flows
    - Hydrate particles agglomeration
    - Hydrate dissociation
  - Impact on process
    - Impact on the HC/water separation
    - Interactions with the regenerating solvent (MEG/LDHI formulations)

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RESPONSIBLE OIL AND GAS

IFPEN proposal

3 main items of interest:

- **Flow Assurance strategy assessment**, evaluation of economic and carbon footprint gains
- Water quality
  - Water/oil separation and water phase quality: efficiency of water-treatment equipments (Hydrocyclone, Flotation, filtration…), efficiency of water clarifiers
  - Impact on MEG reclaiming process
- MEG Reclaiming process (with Axens support)

Axens
Powering integrated solutions
An IFP Group company

IFP Energies nouvelles

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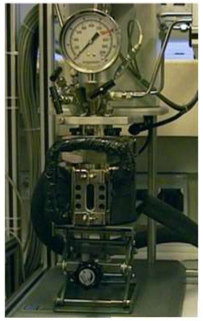
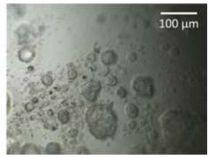
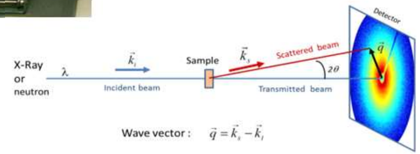
RESPONSIBLE
OIL AND GAS

A first tentative of Technical scope: from lab scale to pilot scale

- Lab scale studies
  - Physical-Chemistry: compliance of MEG and LDHI and system characterization
  - Hydrate tests with under- inhibited MEG system (HP reactor and small-scale flow loop)
    - Impact of a LDHI on hydrate crystallization kinetics and dissociation
    - Impact of AA on rheological behavior
    - Impact of LDHI on hydrate transportability (small flow loop)

- Pilot scale tests (with an optimized system)
  - Hydrate formation tests on the Lyre loop
    - Assess strategy reliability regarding Flow assurance under more representative conditions (single-phase flow/ multiphase flow, low liquid hold-up) – restartability after a shutdown.

- Carbon footprint
  - Comparison of different scenario in term of carbon footprint

TIMELINE AND BUDGET

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- 1st Phase : proof of concept / MEG + AA
- 12 months project
- Ticket cost: 55k€ / sponsor

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