INTECSEA
WorleyParsons Group

JOINT INDUSTRY PROJECT

Mercury Removal from Rich MEG - Key Considerations

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JIP Outline Overview

The presence of mercury (Hg) in gas/condensate reservoirs, particularly prevalent in reservoirs in the Asia-Pacific area, is an environmental and potential production impact consideration that needs to be taken into account in the topsides and onshore processing facilities design and operation.

The monoethylene glycol (MEG) solution (used for hydrate inhibition) coming from subsea wells is commonly 50/50 wt% MEG/water (referred to as Rich MEG). This Rich MEG stream which becomes contaminated with Hg coming from the reservoir, proceeds as the feed to the MEG Recovery Unit (MRU) wherein water and salt are removed in order to clean and reconstitute the solution to about 90/10 wt% MEG/water (referred to as Lean MEG).

There appears to be insufficient publically available information to enable full evaluation of the design considerations needed to properly implement mercury removal from Rich MEG.

A going in position is to develop a design based on removing a sufficient amount of Hg upstream of the MRU, so that the residual amount of Hg left in the Rich MEG, partitioned into the following MRU streams, does not violate any environmental regulations:

1. Overhead produced water (MEG Regenerator)
2. Purge streams if present (either from MEG Regenerator or Reclaimer)
3. Lean MEG (either from MEG Regenerator or Reclaimer)
4. Salt cake (salt handling system)

If this approach does not prove viable then removal on an individual MRU rundown stream basis will need to be considered.

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JIP Objective & Scope

This bulletin provides a brief overview of the main challenges currently facing industry, as identified by INTECSEA and Industry Technical Advisers supporting operators in MEG Regeneration/Reclaiming operations.

The immediate objective is to garner feedback from selected organisations to establish viability for research into an area where little knowledge exists.

By identifying current knowledge, and determining the information gaps that need to be addressed, the courses of action will be defined. If sufficient commitment is provided, INTECSEA will prepare a detailed proposal for review and discussion with JIP participants that outlines literature survey, simulation, and bench/pilot testing objectives to support design guidance objectives. JIP feedback on objectives and approach will be integrated into the approved program.

Current Challenge

Both Hg speciation and partitioning in the MRU is of interest to industry to ensure accurate prediction of Hg passage into MRU streams. Unfortunately Hg speciation/distribution in the MRU system has not been studied to any great extent. However, this information is needed to establish Rich MEG Hg removal efficiency as well as identify where to put Hg removal equipment on individual MRU rundown streams if Hg removal from Rich MEG is not a viable option.

Currently the chemistry and effectiveness of Hg removal from Rich MEG has not been studied, or is not available in the public domain. The presence of Fe^{2+} from pipeline corrosion, as well as Ca^{2+} and Mg^{2+} from Formation Water breakthrough and/or wellhead startup, are potential divalent ion candidates, that often require their own removal processes, and could compete with Hg in the Hg removal process. Since little is known about these interactions further study is required.

Value Drivers

1. To improve the ability to more accurately predict the distribution of mercury in the MRU streams. This will provide design and plant engineers with a basis for establishing optimum mercury removal concepts.
2. To confirm effectiveness of current mercury removal technologies for Rich MEG. This will enable appropriate design of removal facilities, ensuring safe and trouble free operation.
3. To identify the impact of divalent ions on mercury removal from Rich MEG. This will ensure proper positioning of the mercury removal system as well as identify any additional chemistry considerations to maintain proper removal efficiency.
4. Confirm that environmental limitations on plant effluent streams are properly addressed.

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Technical Advisory Team

A "Team" of Technical Advisers in Hg testing and treatment, MEG chemistry, and MRU design and operation has agreed to support (on a reimbursable basis depending upon task and time) the JIP, as required, to help develop/ execute:

- Overall strategy
- Identification of technology and design considerations
- Identification of current know-how and scientific literature
- Simulation work to guide test programs
- Bench test program matrix
- Trial work done on existing facilities
- Pilot test program matrix

Expertise and operational knowledge will be shared by:

Specialist Service Companies:

- Production Chemistry – Nalco Champion: Steve Davoren
    - Facilitate use of NALMET® chemistry, if chosen as a mercury removal process for testing
    - Provide guidance based on Hg removal chemistry and operational data
    - Participation with laboratory selected to execute Hg removal testing
- Process Filtration – DrM Filters: Stewart Tipson
    - Extensive Hg removal experience with leading technology providers
    - Provide guidance based on operational data using pre-coat backwash filters
    - Supply of pilot test filter rig for Hg removal studies
- Sampling and Testing – Intertek Testing Services: Peter Spitz
    - Provide Hg sampling and analytical expertise
    - Provide personnel to go to JIP member site(s) to sample and transport Rich MEG to the lab for analysis at their facilities

Research Institutes:

- MEG Chemistry – IFE (Institute for Energy Technology): Marion Seiersten
    - Provide Rich MEG composition criteria for simulation/test/pilot work that would reflect typical operations
    - Execute simulation work to estimate the impact of divalent ions, expected to be in Rich MEG, on the Hg removal process – for pH stabilized and film inhibitor corrosion programs.

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Consultants:

- Hg Chemistry – Thermochem, Inc.: Darrell Gallup
    - Provide overall knowledge of Hg speciation/distribution in Rich MEG (“dissolved” & “free”)
    - Identify latest technology/literature
- MRU Design – INTECSEA/Advisian (WorleyParsons Group): Tom Latta
    - Provide overall design knowledge of the MRU process

Phase 1 Activities

Development of an overall strategy – time frame ~6 months from JIP kick off meeting

1. Complete Kickoff Meeting:
    a. JIP direction on how to develop the overall strategy:
        i. Identify common areas of key concern that need to be addressed for design
        ii. Identify local environmental regulations concerning Hg discharges
        iii. Identify JIP members interested in having their Rich MEG sampled for Hg
        iv. Identify JIP members that want to field trial Rich MEG Hg removal runs under the auspices of Dr M and Nalco Champion with support from available technical advisers above
    b. JIP member knowledge and operating experience sharing:
        i. Hg concentrations and species in Rich MEG
        ii. Hg partitioning and capture in MRU streams
        iii. Hg monitoring in MRU streams (Hg mass balance?)
        iv. Any other relevant information
2. C omplete literature search of existing Hg equilibrium data with relevant MEG systems to:
    a. Identify what information is available to avoid duplication of test work
    b. Identify what information gaps exist that prevent proper design of a Hg removal system
3. Development of an overall strategy to attain information required to determine:
    a. Treatment of Rich MEG versus individual MRU streams
    b. Proper design of a Hg removal system for either Rich MEG or individual MRU streams
    c. Impact of divalent ions on Hg removal process
    e. Field trial work to be done on existing facilities
    f. Best approach for simulation and bench / pilot testing
    g. Simulation / Bench / Pilot facility or facilities to be used

4. Establish path forward:
    a. Identify items to execute from the overall strategy
    b. Develop budget and schedule for execution in Phase 2 Activities
    c. Establish membership fee for Phase 2 Activities
    d. Issue Report

Phase 2 Activities

Execution of an overall strategy – time frame TBD based on Phase 1 Activities work scope definition

Note: Anticipated activities are listed below.

1. Execution of simulation work program to provide insight into developing bench/pilot work or field trial work on existing units, focusing on:
    a. Divalent ion impact on Hg removal
    b. Scale prevention program impact on Hg removal
    c. Corrosion program impact on Hg removal
    d. Other identified chemistry impacts

2. Execution of experimental program, including:
    a. Validation of experimental techniques to be used by way of replication of specific existing data (if required)
    b. Measurement of vapor and liquid concentrations of Hg in multi-component, multiphase hydrocarbon mixtures containing an aqueous MEG phase upstream of MRU
        i. Includes use of JIP member Rich MEG samples to determine range of Hg species and concentrations involved

3. Identification of work to determine equilibrium data for Hg species in conditions that closely resemble key separation equipment within an MRU. Specifically, the work would include:
    a. Measurement of Hg concentrations and partitioning in:
        i. MRU Produced Water and vent
        ii. MEG Regenerator bottoms
        iii. Lean MEG solutions
        iv. MEG Reclaimer vent
        v. MEG Reclaimer bottoms (purge and or salts)

4. Implement test plan for Hg removal from Rich MEG:
    a. Bench tests
    b. Pilot tests
    c. Field trial tests on a JIP operating facility

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Proposed Ground Rules/Boundaries for Preliminary Discussion:

- All data shared by JIP members will be kept confidential
- Literature search results, Experimental or Simulation Data (if unpublished) produced by the JIP will be made available only to members and is to be kept confidential
- Addition of new JIP members to be voted on by majority consensus
- JIP consensus will be required for:
    - Strategy / execution decisions
    - Funding agreements
    - Publication strategy
    - Distribution / final ownership of assets procured by the JIP
- Field test units supplied by vendors remain the property of the vendor and must be returned
- Work scope items not executed from the overall strategy or new work scope items identified during Phase 2 work could extend into a set of Phase 3 Activities

Fee & Schedule

Phase 1 Activities (~6 months):

- The goal would be to try and establish a group of at least 8 to 10 companies as JIP members
- Execution Fee: $8,000 to $10,000 US (depending on size of membership)
- Additional participants are welcome and will be sought by the collective group
- Kick off meeting - date and location to be determined

Phase 2 Activities (~12-18 months):

- The goal would be to execute all or a portion of the work scope items identified in the Phase 1 Activities.
- Estimated Execution Fee: $40k to $50k US (depending on size of membership) to support rudimentary simulation/bench/pilot work or trial runs at an existing facility
- Depending on JIP membership consensus as to what Phase 2 Activities will be implemented, the fee for Phase 2 will be adjusted accordingly
- Identify future activities for Phase 3

Phase 3 Activities (Future):

- If future work is desired, JIP members to agree on objectives and funding

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