Sour Water Treatment
At Habshan 3 (Unit-372)

Innovative Solution

Prepared and Presented by:
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MESPON - 18th October 2015
GASCO HB-3 : System overview

[Diagram of the system overview]
The Challenges Prior to the Treatment

**Flash Drum**
- High floatable solids, high hydrocarbon content in sour water

**Holding tanks A & B**
- High floatable solids and hydrocarbon. No phase separation.

**In Line Filter**
- Operated with 100 micron mesh to avoid filter choking.

**Plate Heat Exchanger**
- Bypassed to avoid choking due to high suspended solids & HC.

**Stripper Column**
- High level of deposition on trays & choking of nozzles.
- High ∆P observed whenever feed rate increased i.e. > 25 m$^3$/h
- Frequent steaming out in order to dislodge deposits and improve heat & mass transfer.

**Stripper Overhead**
- Low overhead temperature & low pH of condensate.

**Reflux Drum**
- Low pH of condensate and emulsification of water with Hydro-carbon.

**Re-boiler**
- Bypassed due to carryover and deposition

**Stripper Bottom Cooler**
- Under deposit corrosion & tube leakage in stripper bottoms trim cooler which led to high temperature in downstream waste water treatment unit.
GASCO expectations

- To resolve feed filter quick clogging issue and reduce feed filter size initially from 100μ to 40 μ and finally to less than 10 μm.
- To take feed preheater PHE on line.
- Minimize deposition in the stripper column.
- To take reboiler in service and stop direct steam to stripper
- Minimize salt deposition in overhead condenser and reflux trays.
- Maximize the feed to design with clear, on spec stripped water quality.
ASOS & GE Feedback To GASCO

Extremely high presence of inherent surface active agents loaded from upstream, makes the Sour Water unmanageable for Phase Separation and treatment at SWS inlet.

The problematic components: Inorganic Scalants, dead biomaterials, other Solid mass, Surface active agents, Non-purgeable hydrocarbons, Acid Gases, Corrosion products, loaded into the process streams make snowball effect to challenges.

Root causes remediation is impractical and hence in the dynamic plant, direct Emulsion Breaker chemistry cannot be a sustainable option throughout the process.

GE scheme primarily aims in the management of such components through reverse-chemistry.

The resultant benefits will be visible immediately, but more tangible benefits will be visible through the trial period when the unit is in full operation.

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Treatment KPI’s proposed by GASCO

Begin by cleaning of the whole Sour Water system including Stripper
Minimize/Control Development of Black materials that leads to accumulation of in the settling tanks.
Minimize clogging of on-line micron filter. Reduce Filter sizing to 50 micron.
Minimize Inorganic/Organic deposition in the on-line plate heat exchanger.
Minimize deposition in the stripper nozzles and trays. Operate stripper with overhead temperature above 110 degC.
Utilize and operate the re-boiler for optimum system performance.
Minimize deposition in the overhead re-circulating piping of the stripper column.
Maximize operation of sour water system to achieve clean HC free treated water.

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Laboratory Study carried out by GE W&PT

With the Sour-Water Samples provided by GASCO, GE W&PT had carried out extensive tests in their laboratory in UAE and Belgium to understand the existing challenges faced by GASCO as well as identified the most suitable chemistry for this application.

Scaling and Fouling Potential Survey:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Status</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>200</td>
<td>&gt;20. High</td>
</tr>
<tr>
<td>Speciation&gt;100µ</td>
<td>Not done</td>
<td>To be NIL</td>
</tr>
<tr>
<td>C7+ studies</td>
<td>Not done</td>
<td>High Presence</td>
</tr>
<tr>
<td>Liquid Purge</td>
<td>Incomplete</td>
<td>Design</td>
</tr>
<tr>
<td>RSI, LSI etc</td>
<td>Scaling during Process</td>
<td>PHE, Tower, Reboiler, Nozzles</td>
</tr>
<tr>
<td>Corrosion</td>
<td>Overheads</td>
<td>Unprotected</td>
</tr>
<tr>
<td>Metal content</td>
<td>3-5 ppm Liq, 5-10% deposits</td>
<td>Upstream</td>
</tr>
<tr>
<td>Quiescence potential</td>
<td>Process</td>
<td>High</td>
</tr>
<tr>
<td>Metal temp limit</td>
<td>OK within limit</td>
<td>LP steam</td>
</tr>
</tbody>
</table>

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Laboratory Study carried out by GE W&PT

Deposit Analysis from Sour Water Sample:

After conducting LOI at 110 degC, the mass left on the filter paper was like black cotton wool. After conducting LOI at 550 degC, the mass left behind was very little and like fine powder. From the above we conclude that the Metallic & other insoluble inert matter in the deposit are very less. Hydrocarbon, dead bio-mass (organic matter) and other Floatable content in the deposit sample are high.

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Product Selection Criteria: GE W&PT

Investigations-2....

MIX OF I/L + O/L + 500PPM OF MAX-AMINE 57C

MIXED SAMPLE FROM THE PREVIOUS KEPT BLANK AS BENCHMARK
BLANK + 500PPM 57C - BEFORE HEATING
BLANK + 500PPM 57C - HEATED UP TO 100 deg.C
BLANK + 500PPM 57C - HEATED UP TO 100 deg.C & FLASHEO OFF THE VAPORS

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>TK 1018 I/L</th>
<th>SQUEEZED TK 1018 I/L SW + 57C</th>
<th>SQUEEZED TK 1018 I/L SW + 57C + 5K655</th>
<th>BLANK (1:1 RATIO OF I/L &amp; O/L)</th>
<th>HEATED BLANK + 500PPM 57C</th>
<th>HEATED BLANK + 50 PPM 5K655</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.61</td>
<td>8.89</td>
<td>9.1</td>
<td>8.58</td>
<td>8.73</td>
<td>8.52</td>
</tr>
<tr>
<td>microS/cm</td>
<td>3870</td>
<td>2200</td>
<td>2080</td>
<td>1291</td>
<td>1364</td>
<td>1596</td>
</tr>
<tr>
<td>TSS</td>
<td>2355</td>
<td>11</td>
<td>43</td>
<td>653</td>
<td>35</td>
<td>52</td>
</tr>
<tr>
<td>TDS</td>
<td>2516</td>
<td>1430</td>
<td>1352</td>
<td>839.15</td>
<td>887</td>
<td>1037</td>
</tr>
<tr>
<td>mAlk</td>
<td>---</td>
<td>1047</td>
<td>933</td>
<td>375</td>
<td>766</td>
<td>385</td>
</tr>
<tr>
<td>Ca Hardn</td>
<td>---</td>
<td>213</td>
<td>80</td>
<td>30</td>
<td>44</td>
<td>33</td>
</tr>
<tr>
<td>Temp</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>LSI</td>
<td>---</td>
<td>3.49</td>
<td>3.23</td>
<td>1.91</td>
<td>2.54</td>
<td>1.89</td>
</tr>
<tr>
<td>RSI</td>
<td>---</td>
<td>1.98</td>
<td>2.73</td>
<td>4.94</td>
<td>3.82</td>
<td>4.92</td>
</tr>
</tbody>
</table>

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Product Recommendation By GE W&PT

<table>
<thead>
<tr>
<th>Products</th>
<th>Application Methodology</th>
</tr>
</thead>
</table>

The primary objective of the proposed chemistry would be to extend the system run time and reduce the frequency of unscheduled shut downs.

Smooth and correct system operation is mandatory.

For optimum product performance, the chemical injection should be done at the locations indicated in the attached schematic, using existing dosing systems.
GE Chemical Dosing and its Effects

TSS = 1194 ppm
23.5 m³/hr

TSS = 523 ppm
32.7 m³/hr

TSS = 478 ppm
Till 13th June
100 micron
14th June onwards 40 Micron

TSS = 76 ppm

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Unit-372: Sour Water Quality After Chemical Application
Unit-372: Sour Water Quality After Chemical Application

TSS Loading Before & After Inline Micron Filter: F101 (A/B)

TSS Loading & Flow through Stripper Column: V106
What We Achieved Through The Trial

• Un-interrupted system operation.
• Utilize existing chemical dosing system to dose recommended chemicals.
• Prevent settling of suspended material in the receiving Tanks.
• Utilize in-line-filters which did not have any choking even when the mesh size was reduced to 40 micron from 14th June 2015.
• The PHE was taken in operation and no pressure drop was observed across the PHE.
• No deposition in the stripper nozzles and trays were observed. Stripper operated with Overhead temperature of 115 – 120 degC since 3rd July 2015.
• The re-boiler was operated without any problems since 3rd July 2015.
• No deposition in the overhead re-circulating piping of the stripper column and reflux system.
• No corrosion observed. In flash drum, Fe++ pick-up dropped from 5 ppm to ~2 ppm after MAXAMINE 57C dosing.
• Condensate was recovered from reflux drum and re-circulated back to Stripper.
• Clean, particulate and HC free, treated water at the Stripper Outlet (Bottom)
# Performance over 4 Months of Treatment

<table>
<thead>
<tr>
<th>Objectives of Treatment</th>
<th>No Treatment</th>
<th>Treatment Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Injections (ME-101, 102, 103)</td>
<td>Not in operation</td>
<td>In operation</td>
</tr>
<tr>
<td>Receiving Tanks Inlet TSS</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Micron Filter Outlet TSS</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Micron filter</td>
<td>100 micron</td>
<td>100 to 40 micron</td>
</tr>
<tr>
<td>PHE operation</td>
<td>Not in operation</td>
<td>In operation</td>
</tr>
<tr>
<td>Stripper overhead Temp</td>
<td>60 degC</td>
<td>65 – 75 degC</td>
</tr>
<tr>
<td>Separation in Reflux drum</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Recirculation of condensate to stripper column</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Re-boiler in Operation</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>TSS of Treated SW</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Level of Hydrocarbon in treated Sour water</td>
<td>Low</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

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Conclusion: Did we achieve our goals?

- Primarily we were able to achieve all the proposed and expected GOALS
- Presently UNIT372 can be operated while utilizing all equipments/systems
- We can further reduce the filter mesh size to 25 micron and then to 10 micron in the next 60 days, while continuing with the recommended treatment
- Once the leak in the PHE is rectified and put in normal operation, the performance of the Unit372 will improve further.
- With the continued chemical treatment we expect the TSS and HC content of the treated water to be further reduced.
- Similar treatment approach is now being implemented in other Sour Water Systems in Habshan.

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Thank You
GASCO Team

This success is attributed to your Support & Cooperation

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