Not Your Father’s H₂S Scavenger

Crude Oil Quality Association
March 3, 2016

Dr. Lawrence Karas
Senior Staff Scientist
Agenda

Outline

- Overview: Novel Non-Triazine H₂S Scavenger
- The Industry Standard: Triazines
- HSCV10273A
  - Product Overview
  - Physical Properties
  - Field Evaluation
  - Laboratory Evaluations
The Industry Standard: Triazines

Non-Regenerative $\text{H}_2\text{S}$ Scavengers
Triazines
Non-Regenerative H₂S Scavengers

Advantages
- Globally Available
- Decent Economics
- Industry Proven
- Formulation Flexibility
- Application Flexibility

Disadvantages
- pH: 10 or Higher
- Scale Deposition
- High Volatility (MMA Triazine)
- Base Amine Can lead to challenges with corrosion
- Insoluble Reaction Products
- Solids Require Mechanical Removal or Line Removal
HSCV10273A
Novel, Non-Triazine $\text{H}_2\text{S}$ Scavenger
New Key Innovation: Non-Triazine H₂S Scavenger

Description of Technology:
- Non-Triazine H₂S scavenger for oil, water and gas streams

Benefits Compared to Triazine:
- Higher Capacity for H₂S Removal
- High Reaction Kinetics
- Lower pH
- Lower Amine Content
- No Volatile Amines

Status of Project:
- 3 Year Development Project
- Patent Pending
- Commercialization March 2016
HSCV10273A
Physical Properties

- Flash Point = 113°F (45°C)
- Specific Gravity @ 20°C = 1.0996
- pH (Neat) = 8.76
- pH (10% in 3:1 IPA:DI Water) = 8.65
- Pour Point = -40°F (-40°C)
- Viscosity: 30cPs at 70F
HSCV10273A
Field Studies
Field Trial: Bakken Shale

- Full Well Stream, Topside, Continuous Injection
- Target: Comparison vs. Triazine/Scale Inhibitor Product
- Result: Sweet Tooth removed an additional 36% removal (H₂S per lb) with lower volume

<table>
<thead>
<tr>
<th>Product</th>
<th>Injection Rate</th>
<th>H₂S Inlet</th>
<th>Average H₂S Outlet</th>
<th>Gas Production</th>
<th>H₂S Removed</th>
<th>Actual Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triazine</td>
<td>15.00</td>
<td>1500.00</td>
<td>400.00</td>
<td>0.073</td>
<td>7.26</td>
<td>2.07</td>
</tr>
<tr>
<td>HSCV10273A</td>
<td>12.00</td>
<td>1500.00</td>
<td>4.00</td>
<td>0.073</td>
<td>9.88</td>
<td>1.21</td>
</tr>
</tbody>
</table>
A sample of H$_2$S scavenger is dosed into a 50/50 (vol%) mixture of 1-octanol and water

- Two samples
  - Neat Product: A sample H$_2$S Scavenger before reaction with H$_2$S
  - Reaction Product: A sample of H$_2$S Scavenger post reaction with H$_2$S

The samples are mixed and separated by gravity

- Aliquots from the 1-Octanol phase and water phase are analyzed through analytical instrumentation
- The amount of each sample is quantified for each fluid medium
- The values are provided as overall percent

<table>
<thead>
<tr>
<th>Sample</th>
<th>1-Octanol</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Neat Product</td>
<td>10.5</td>
<td>89.5</td>
</tr>
<tr>
<td>Reaction Product</td>
<td>92.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>
The evaluation is a static test to observe changes in emulsion tendencies.

A water-in-oil emulsion is prepared under shear with the addition of an emulsion breaker and the test samples.

- Blank Sample
- 2 Test Samples:
  - Neat H₂S Scavenger
  - Reaction Product

The emulsion is poured into glass tubes and placed into the PED unit where the emulsion is exposed to heat and electric field.

The resolution of the emulsion is noted by the volume of water resolved during the period of time of testing.

- Voltage = 500 volts - 1500 volts applied for one minute.
- Duration = 60 minutes
- Temperature = 248°F (120°C)
- Fluid Medium Volume = 100 mL: 95 mL of crude oil and 5-mL of washwater
HSCV10273A
Portable Electric Desalter Evaluation

**Results**

- No negative impacts in emulsion tendencies were observed with the addition HSCV10273A or the reaction product.
Neat Corrosion Evaluations

<table>
<thead>
<tr>
<th>High Temperature</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Set Up</td>
<td>Static Autoclaves</td>
</tr>
<tr>
<td>Metallurgy of Coupon</td>
<td>Mild Steel F-22</td>
</tr>
<tr>
<td>Temperature</td>
<td>250°F</td>
</tr>
<tr>
<td>Duration</td>
<td>14 Days</td>
</tr>
<tr>
<td>Corrosion Rate (Active)</td>
<td>1.1 mpy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low Temperature</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Set Up</td>
<td>Glass Vessels</td>
</tr>
<tr>
<td>Metallurgy of Coupon</td>
<td>SS 304 and SS 316</td>
</tr>
<tr>
<td>Temperature</td>
<td>130°F</td>
</tr>
<tr>
<td>Duration</td>
<td>84 Days</td>
</tr>
<tr>
<td>Corrosion Rate</td>
<td>0 mpy</td>
</tr>
</tbody>
</table>
HSCV10273A

Summary

- Nalco Champion has developed a novel non-triazine H₂S scavenger
  - EPA approved
  - In final stages of commercialization

- HSCV10273A exhibited superior scavenging capacity as compared to triazines without scale formation in upstream applications

- Early laboratory evaluations indicate less detrimental effects than triazine