Gas Well Deliquification: From lab to field

Presenter:
Steven Oude Heuvel
Sr. Development Chemist
Agenda

- Short Summary
- Going from the lab to the field
- Request and analyze data
- Assess benefits of foam
- Product selection
- Monitoring and adjusting program
- Case Histories
Short Summary
Previously presented in this forum

In 2012 Champion Technologies, now Nalco Champion, presented on the development of Foamatron V-505

Product met a wide variety of KPI’s including:

- Non carcinogenic
- CEFAS non-sub product
- Corrosivity vs Alloy625, 9Cr1Mo, 316 SS, C1018
- Temperature stability (1 month at 130 C)
- High performance in low and high saline conditions
- Compatible with actual well fluids
- Low viscous over broad temperature band (<150 mPas between 40 and -20C)

So how do we go from this lab data to the field?
Going from the lab to the field
Nalco Champion’s 5-step Process

1. Work with the customer to get a good data set to base the work on

2. Assessing potential benefits a foamer technology application might provide, using updated model; estimate gas production increase

3. Ranking of wells by production improvement potential

4. Selecting, testing and applying the most appropriate chemical solution

5. Monitoring production and KPIs, and making any necessary treatment adjustments
Well data collection
Comprehensive Analysis of Situation

- Nalco Champion will work with operators to comprehensively evaluate wells

- Some data is required

- Data is captured by use of a data sheet

- Quality of the data determines the quality of the output
Comprehensive Analysis of Situation

Data requirements:
- Flow rates of gas, water and condensates
- Basic fluid properties (ao: SG, basic composition)
- Well dimensions (id’s), depths (EOT, packer depth) and geometry (MD, TVD or plot)
  OR
- Well diagram
- Pressures and temperatures
- Additionally decline curve analysis, slugging behavior and other liquid loading indicators can be shared.
Assess benefits of chemical foamer
PerFoam Model: Revised and Improved

- The legacy models of both Nalco and Champion Technologies are being combined into a new model

- Best points of both are being retained

- This leads to improved candidate selection

- Better application of product, leading to more gas production
PerFoam Model

Calculates above or below critical based on tubing and casing data.
Recommendations for well treatment

- Graphic of the recommendations by potential for improvement

- One of the outputs of the new PerFoam model is the recommended application method combined with the flow potential

- This means wells can be ranked on best ROI
## Recommendations for well treatment

<table>
<thead>
<tr>
<th>Well Identification</th>
<th>Data</th>
<th>Flow potential</th>
<th>Current Well Flow</th>
<th>Max Flow Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well ID</td>
<td>Date</td>
<td>Absolute open flow</td>
<td>% of open flow</td>
<td>sm3/d</td>
</tr>
<tr>
<td>Well A</td>
<td>11/09/2014</td>
<td>93639.93</td>
<td>78.40</td>
<td>73417.00</td>
</tr>
<tr>
<td>Well B</td>
<td>11/09/2014</td>
<td>47848.08</td>
<td>81.64</td>
<td>39061.44</td>
</tr>
<tr>
<td>Well C</td>
<td>11/09/2014</td>
<td>61299.50</td>
<td>81.88</td>
<td>50194.12</td>
</tr>
<tr>
<td>Well D</td>
<td>11/09/2014</td>
<td>45937.16</td>
<td>78.87</td>
<td>36229.74</td>
</tr>
<tr>
<td>Well E</td>
<td>11/09/2014</td>
<td>49799.99</td>
<td>80.71</td>
<td>40194.12</td>
</tr>
<tr>
<td>Well F</td>
<td>11/09/2014</td>
<td>60853.54</td>
<td>82.48</td>
<td>50194.12</td>
</tr>
<tr>
<td>Well G</td>
<td>11/09/2014</td>
<td>54924.16</td>
<td>80.05</td>
<td>43964.38</td>
</tr>
<tr>
<td>Well H</td>
<td>11/09/2014</td>
<td>44898.73</td>
<td>80.69</td>
<td>36229.74</td>
</tr>
</tbody>
</table>
Recommendations for well treatment

- Output from model is a recommendation on the application of the product.

- Treatment volumes are also included; combine dosage of foamer required (in ppm) with estimated fluid retains.

- Data is based on a standard active material product.
Recommendations for well treatment
Selection and application of foamer
Selection of the Chemical

- A Nalco Champion application expert will combine the results from the PerFoam study with results of a laboratory study.
- Diluted product might be better for low volume applications.
- Study is based on the ASTM D-892 method.
- Currently a JIP is ongoing to see if this is the best method for foam selection. A presentation on this subject was just given by TNO.
ASTM D-892 (Dynamic Unloading Rig - modified)

Unloading Efficiency (%) = \( \frac{W_{\text{unloaded}}}{W_{\text{initial}}} \times 100 \)
ASTM D-892 (Dynamic Unloading Rig - modified)

% Unloading vs Time
400 ppm active foamer and 75% Condensate

Other data accessed can include: foam built-up time, volume, stability etc.

Foamer A
Foamer B

timeFoam >1000ml
ASTM D-892 Dynamic Unloading Rig - modified

- Foam characteristics generated under dynamic conditions and better simulates deliquification conditions
- Can be used to quantitatively rank the performance of surfactants
  - Predictability of foaming ability of surfactants in dynamic conditions
  - Can be used with hydrocarbon
  - Can be used to predict minimum dosage to achieve unloading
  - Can be tested at limited elevated temperatures
Product, well, and rates

- Wells are now ranked by potential

- Product is selected

- Injection rates are estimated with recommended application method

- So how do apply in the field for the best results?
Applications Methods – Batch Treatment

- **Batching down the backside**
  - Only on packerless completions

- **Batch and Fall**
  - Good if the well can be “rocked”
  - If there is a very high level of loading

- **Bull heading or tubing displacement**
  - Use a volume of flush to drive the chemical into location

- **Foam Squeeze**
  - Can be achieved with liquid or gas and the post-treatment flush
Applications Methods – Continuous

- Drip feed down the annulus
  - If packerless completion

- Capillary strings
  - Depending on completion strings can be run down inside the tubing or banded on the outside of the tubing
  - Various types of atomizers and nozzles available
  - Placement is key to performance
  - Need to ensure that the chemical is delivered to the correct location
  - Typically aim for top perforations
  - Not always easily applicable due to SSSV & integrity requirements

- Can be used in addition to other artificial lift methods
  - Can occur via the gas lift system
Monitoring and adjusting program
Ensuring Success

- Nalco Champion will track the progress of the batches and monitor the KPIs
  - Increase in gas production
  - Increase in fluid production
  - Oil in water levels

- If required adjustments to product, application or rates can be made to optimize performance
Case Histories
Success Story #1 – North Sea Gas Well

The diagram illustrates the comparison of gas production (in MMscf/d) before and after treatment for wells F1, F3, F5, and F11.

- **Pre Treatment**
- **Post Treatment**

The vertical bars show the increased gas production post-treatment, indicating the effectiveness of the treatment process.
Success Story #2: Onshore Wells

Well A production

Well A Injection
Success Story #2: Onshore Wells

Well B Production
Well B Injection
Thank you for your attention

Special thanks to co-writers:
Scott Caird
Sjoerd van der Knoop