Local experience regarding downhole surfactant injection in south of France

J.Monsma (Total EP France), V.Peyrony (Total SA)
Meillon Saint Faust (MSF) field: challenging environment..

- Deep wells: ~4500 m (~13000 ft)
- Mainly 5" completions, dual safety valves.
- Hot: 155 °C (310°F)
- Gas rates: ~ 50 KSm3/day (~ 1400*10³scft/day)
- Water rates: WGR > 1500m3/10⁶Sm3 (0.336 bbl/10³Scft)
- Free condensates, 6% H2S, 9% CO2
- Scales (CaCO3, BaSO4)
- Nearby separators and compressors (defoaming required!)
- HSE & Safety requirements…
PROJECT HISTORY

“Dewatering” main topic of "Water Management on the Meillon field“

“Cap. String” project start-up date: December 2005

Project set-up in 3 phases:

- **Phase 1:** Through samplings and analysis: search for the best adapted chemical(s), followed by a first set of tests on several wells. Search for the best adapted surfactant(s).

- **Phase 2:** Enhanced well-testing through **batch-injections** (appropriate treatments volumes). Searching for the most economical injection-mode of surfactants / selected well (Batch versus Capillary String). Sizing of the future pilot of continuous surfactant injection.

- **Phase 3:** Design & execution of the continuous surfactant injection pilot:
  Status Sept. 2007: One cap-string installed (LLT1), one in progress.
PHASE 1  (Dec 2005 - Mar 2006)

- Selection of specialized company to assist the project.
  - Services, chemical selection, injection optimization

- Sampling and analysis of liquid phases on 8 (MSF) wells
  - BAY 1, LLT 6, MZS 4, PTS 3, PTS 5bis, RSE 1, RSE 3, SFT 16.

- Laboratory selection of foamer & defoamer agent compatible with the field conditions:
  - Foaming agent: shall also be inhibitor carrier – "green" product required
  - Defoamer: non-solvant based: no BTX

- Solid surfactant tests (foam sticks)  
  - Conclusion: sticks not industrially feasible….

- Liquid surfactant tests on BAY 1 and MZS 4  
  - Conclusion: obvious interest to continue….
PHASE 2  (Field tests: Sept - Oct 2006)

Objectives:

- To determine the most suitable surfactant injection mode on MSF wells.
- Confirm suitability of selected chemicals.
- **Sizing of the future continuous surfactant injection pilot on 2 wells.**

Main Works:

- **Reference testing of wells** (reference shut-ins and start-ups, dry runs, wireline)
- **Double batch-treatments on 7 wells** (PTS 5bis, LLT 4, BAY 1, SFT 7, MZS 4, SFT 16, LLT 1).
- **Interpretation of batch-tests.**
Phase 2: LLT1: reference test & downhole pressure reaction…

LLT1 surfactants tests phase 2

Reference start-up (no surfactant)
First surfactant batch
Well unloading

Roughly 15 KSm3/d gain in gas flow
Roughly 10 bars reduction in BHFP
## PHASE 2: results…

<table>
<thead>
<tr>
<th>WELL</th>
<th>Q before treatment (KSm3/day)</th>
<th>Batch</th>
<th>Gain of gas after 30 hrs (KSm3)</th>
<th>Gain of water after 30 hrs (m3)</th>
<th>BATCH</th>
<th>CAPILLARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLT 4</td>
<td>190</td>
<td>1: 350 L</td>
<td>0</td>
<td>0</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>PTS 5bis</td>
<td>75</td>
<td>1 : 250 L</td>
<td>0</td>
<td>6 m³</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 : 125 L</td>
<td>0</td>
<td>4 m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFT 7</td>
<td>38 INTERMITTENT</td>
<td>1 : 350 L</td>
<td>Eased start up</td>
<td>T° increase</td>
<td>+ +</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 : 350 L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAY 1</td>
<td>68</td>
<td>1 : 175 L</td>
<td>38 KSm³</td>
<td>- 6 m³</td>
<td>+ + +</td>
<td>+</td>
</tr>
<tr>
<td>MZS 4</td>
<td>25</td>
<td>1 : 75 L</td>
<td>0</td>
<td>T° increase</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 : 150 L</td>
<td>0</td>
<td></td>
<td></td>
<td>To be evaluated</td>
</tr>
<tr>
<td>SFT 16</td>
<td>70</td>
<td>1 : 625 L</td>
<td>11 KSm³</td>
<td>40 m³</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td>LLT 1G2</td>
<td>15</td>
<td>1 : 100 L</td>
<td>25 KSm³</td>
<td>100 m³</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 : 150 L</td>
<td>Shut-down during flow-back</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BAY 1… Batch performance

- Self-killing problems...
- First surfactant batch
- Negative attempts to start well by rocking

8 - J.Monsma (Total EP France), V.Peyrony (Total SA)
PHASE 3: MSF CAPILLARY STRING PRINCIPLE

**WELL equipment:**
- Use of the existing lower SCSSV-nipple for landing string hanger.
- Cap-string hanger with integrated check-valve.
- String-end run on top of first production zone (LLT1 4400mD: to top of the slots in liner)
- A pressure rated bottom check-valve to maintain full column-weight of the surfactant within the capillary.

**SURFACE equipment:**
- Injection-system of surfactant in the well (through the control line of lower down hole safety valve)
- Injection-system of defoamer in the well's production line.

**Cap String Running principle:**
- Hydraulic unit (mini CTU) to run ¼” cap-string in hole.
- BOP stack with slip rams to hang-off string during swab from injector-head to HD wireline.
- HD slick-line unit to end the descent and set the suspension.
PHASE 3: LLT1 CAPILLARY STRING OPERATION

Main actors:

  - string design, coil delivery, running equipments, program and job execution
- The Expro Group, Emmen & Aberdeen.
  - wireline services: string and hanger landing
PHASE 3: LLT1 CAPILLARY STRING OPERATION
PHASE 3: LLT1 CAPILLARY STRING OPERATION

Reel with 9175 m (28000 ft) ⅛" string Inconel 625

Pressure rated bottom check valve (400 bar - 5800 PSI)

HD-slickline wire (0.160") to run hanger to nipple.

Injection system with 50µ HP-filters; anti-siphon (!), dP, P, and PSH transmitting.

- Smooth ....
  - Un-reeling of coil caused some challenges: loose windings on reel as from manufacturer.
  - One real with single length for 2 wells: to be avoided.
  - HD slickline unit 0.160” wire): not a conventional unit, especially at -63 m depth.

- Successful descent of coil to planned depth of 4400 mD
  - Proven hanger-seal tightness trough injection pressure increase while landing (rated check valve).

- BJ/Dyna hanger-design and running procedures = good quality.
  - Inconel 625 capillary and Uranus45N hanger material (H2S service).
  - All pull and pressure tests ok on first attempts.

- Good job preparation, service quality, HSE and team spirit onsite.

- Second well (MSZ4) soon ....................
LLT1 start-up with Cap-string injection (03-Sep-2007).

Surfactant injection on LLT1 started 03-Sep-2007....:

- Surfactant injection pressure behavior not yet fully understood: obvious coil ballooning/stretching/Torricelli effects vs pressure rated check valve?
- Clear evidence of frictional P-difference when pumping water or surfactant !!! (density understood but coil friction and friction though check valve: not)
- Clear evidence of big difference between check-valve opening pressure and hold-open pressure !!! (> 120 bars in our case: temperature dependent?)
- Unexpected storage-tank siphoning, despite rated bottom check-valve & regardless volumetric pump: anti-siphon valve installed ASAP.

……………..

Assistance from MULTICHEM, Oklahoma USA.

(Basic cap-string injection rules: never stop injection, inject one string-volume/day, in case prolonged stop rinse string with de-mineralized water, ....)
LLT1 Cap-string injection (started 03-7-2007).
LLT1 Cap-string injection (observation:).

good deliquification !!
CONCLUSIONS  CAP-STRING Project on MSF (so far....)

- Surfactants technology is applicable on Meillon Saint-Faust field:
  - High temperature / Deep / H2S / Condensates / ....
  - Lifting of "normally non-eruptive WGR’s!!
  - LLT1 reaction shows deliquification potential!!

- Key-factor is selection to get a good fit between wells and chemicals.
  - Efficiency of foamer & defoamer/breaker, correct dosage (foam locking), ....
  - Products are compatible HSE (green): no process impact (yet).

- Not so easy application on selected wells.
  - Work over avoided (use of second SCSSV nipple) but stabilization of injection through check valve difficult to achieve so far..
  - Successful descent on LLT1!!

- Importance of (production) team implication.
  - Follow-up of the well’s production and decline (optimization batch or dosage)
  - Analysis and time of reaction.

- Economical.
  - BAY1 batch treatments: 33 K€ expenditures vs 3740 K€ gas-revenue in 8 months.
  - LLT1 cap string: CAPEX: estimated 7 months pay-out (at 35 KSm3/day > dependent on water cost).
Quick Messages…. *(TEPF’s "Surfactants learning curve")*…..

- Well reaction appears unpredictable ▶️do not assume: field test your well!
- Know the bottleneck ▶️be sure it’s the loading of fluid gradient in well bore.
- Do not underestimate surface constraints ▶️process impact, safety logic, manpower.
- Sometimes, water appears to be condensate ▶️sampling & testing procedures
- Persevere in field testing: learning curve…..