Innovative Failsafe Capillary Injection System Resolves Liquid Loading in Gas Well with a Cost-Effective Solution that Maintaining Production and Well-Safety Requirements

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Presentation

- Introduction
- ENI field trail and solution
- The Capillary Deliquification System
- Conclusions
Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements

**Water Loading**

- Many mature Gas wells have had to be shut in due to water loading in the production string

The actually possible solution

Periodically injecting chemicals from surface

or

but

Continuos injection of a downhole, foaming agent can be used

If an injection line is part of the completion string

This presentation describes the first ENI field trial of a Capillary Deliquification Safety System that can be retrofitted into existing wells with rigless intervention to quickly reinstate production.
Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements

- Eni, in the attempt to find a possible solution to the Water loading problem in Barbara Field has carried out a series of field test.

- Recent applications have shown that Foaming Agent is the optimum deliquification system to remove water in the production string and improve production rate.

- The Halliburton CAPILLARY DELIQUIFICATION SAFETY SYSTEM offer a cost-effective alternative to rig work over and occasional foaming treatments.

- The synergy of the two system, foamer plus capillary string, allows a good technical solution for water loading especially in gas string, like the off-shore installations in the Adriatic sea, Italy.
Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements

Barbara E #45 parameters

- The Barbara Gas Field was discovered in 1971 and is located offshore in the northern sector of the Adriatic Sea.

- The Barbara #E45 is a well in the Barbara Field recompleted in 2004 with single completion in OHGP with these parameters:
Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements

The Barbara #E45 parameters:

- Depth max = 1142 mMD
- Deviation max = 27.5 deg at 550 mMD
- Completion Type casing 7-in. 29# @ 1120mMD
- tbg 3-1/2-in. 9.2# to 1099 mMD
- Open Hole 8 ½-in. 1120 – 1142 mMD
- Minimum ID 2.750-in. @ 502.64 mMD
- STHP ≈35 bar
- WHP ≈20 bar

The small production of water, 0.6 mc/day, decreases the productivity and, only after 12-24 hours, the production is completely stopped. Since one year the well was in shut-in condition.
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The Capillary deliquification Safety System

- The Capillary Deliquification Safety System, has been developed to facilitate delivery of foaming agents or other chemical and liquids to a specified depth within the completion while maintaining the operability of a downhole safety device, i.e. SCSSV.

- The system can be installed in an existing completion with the Surface Controlled Subsurface Safety-valve wireline Retrievable or Tubing Retrievable where the communication of the control system is activated to operate an installed wireline-retrievable safety valve (WLRSV).

- The injection feature is operated via the control system for the WLRSV.
- Use the existing control system as injection lines means that a modification of the well head is not require
Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements

The Capillary deliquification Safety System

- The most important tool of this system is the Wire line retrievable surface controlled subsurface safety valve (WR-SCSSV) and the injection check valve.
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- This safety valve has the same features as a standard wireline retrievable safety valve with the addition of a chemical injection feature supplied by the control line that operates the WLRSV.

- When the control-line pressure reaches the predetermined pressure, a check valve installed below the valve opens, allowing the chemical injection to take place while maintaining the presence of a safety valve.

- A check valve installed below the WLRSV opens when the differential pressure across the seat of the injection valve exceeds the safety valve’s spring set pressure.
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The capillary string used for this application has the following characteristics:
- ¼-in. OD
- Material TP: 316 Ti
- Wall Thickness: 0.049-in.
- Working Pressure: 8744 psi
- Hydraulic Pressure Test: 12.000 psi
- Linear weight: 0.1585 kg/m

The capillary string is connected to the lower section of the WLRSV with a special assembly tool. This allows better distribution of its weight.
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**Operational steps**

- POOH a plug 2.75-in from 503 m (the well was close)
- Perform two calibration with slick line with Gauge Cutter 50 mm to bottom hole and with Gauge Cutter 69,5 mm just bellow the TR-SCSSV
- RIH @ 1120 (top perforation) the Capillary String OD ¼ -in and once @ depth pick up 190 m in order to space out.
- Attach the slickline BHA complete with the WLRSV to the ¼ -in.OD capillary string. Perform test @ 2000 psi – check functionality of WLRSV. Increase to 4000 psi to check integrity of connection
- RIH and set all assembly slickline with .108-in. wire

**Note:** *All operations will be conducted in the “Live” gas well without killing the well*
**Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements**

<table>
<thead>
<tr>
<th>Date</th>
<th>From Hrs</th>
<th>To Hrs</th>
<th>Sequence of Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-mar-10</td>
<td>07:30</td>
<td>12:00</td>
<td>Rig up slickline - flowing capillary string with foamer</td>
</tr>
<tr>
<td></td>
<td>13:00</td>
<td></td>
<td>Fishing plug 2.75-in. At 503 mts - calibrated with 57.7 mm at 1137 mts</td>
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<tr>
<td></td>
<td>14:30</td>
<td></td>
<td>Dummy run lock 2.81-in. @ 203 mts</td>
</tr>
<tr>
<td></td>
<td>14:30</td>
<td>15:00</td>
<td>Rig down slickline -</td>
</tr>
<tr>
<td></td>
<td>15:00</td>
<td>18:00</td>
<td>Rig up surface equipment for coiled-tubing services</td>
</tr>
<tr>
<td>25-mar-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-mar-10</td>
<td>07:00</td>
<td>10:30</td>
<td>Run capillary string under pressure of 500 psi @ 1133 mts tr</td>
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<tr>
<td></td>
<td>10:30</td>
<td>15:30</td>
<td>Pumped 30 liters at bottom hole at the flow rate of 158 Lts/Day</td>
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<tr>
<td></td>
<td>15:30</td>
<td></td>
<td>Space out - BOP closed and tested in back flow. Results OK</td>
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<tr>
<td></td>
<td>17:30</td>
<td></td>
<td>Bleed off capillary string to &quot;0&quot; psi , OK</td>
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<tr>
<td>27-mar-10</td>
<td>06:30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>09:30</td>
<td></td>
<td>Bleed off BOP capillary, OK- Connected WLRSV 2.813&quot;</td>
</tr>
<tr>
<td></td>
<td>09:30</td>
<td></td>
<td>Capillary string 1/4-in. – Performed circulating test at 4800 psi</td>
</tr>
<tr>
<td></td>
<td>12:00</td>
<td></td>
<td>Disconnected WLRSV - flow total volume of capillary string</td>
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<tr>
<td></td>
<td>12:00</td>
<td></td>
<td>reopened check valve 1-in. @ 2300 psi - Reconnected WLRSV</td>
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<tr>
<td></td>
<td>13:00</td>
<td></td>
<td>2000 psi OK - open check valve at 2300 psi OK - visual test of the WLRSV, OK</td>
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<tr>
<td></td>
<td>15:00</td>
<td></td>
<td>Run capillary string with slickline, landing on TRSV In - OK</td>
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<tr>
<td></td>
<td>15:00</td>
<td>17:30</td>
<td>Energized Vee-packings OK</td>
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<tr>
<td></td>
<td>15:00</td>
<td></td>
<td>Flowed 15 liters - flow rate 18 Lts/day with pressure of 2400 psi</td>
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<tr>
<td>28-mar-10</td>
<td>07:45</td>
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<tr>
<td></td>
<td>09:30</td>
<td></td>
<td>Opened well head - discharged about 70 liters/hour of fluid foamer</td>
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<tr>
<td></td>
<td>09:30</td>
<td></td>
<td>At 18 Lts/day - defoamer at 36 Lts/day - production rate 30,000 std m³/D</td>
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<tr>
<td></td>
<td>09:30</td>
<td></td>
<td>Increased flow rate of foamer at 43.2 Lts/day and defoamer</td>
</tr>
<tr>
<td></td>
<td>00:00</td>
<td></td>
<td>At 43.2 Lts/day - discharged about 50 Lts/day of fluid - gas production</td>
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<tr>
<td>29-mar-10</td>
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<td></td>
<td></td>
<td>33,000</td>
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<tr>
<td>30-mar-10</td>
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<td></td>
<td>Continued production rate with the same parameters</td>
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**Job Log**
Innovative Capillary Deliquification Safety System Resolves Liquid Loading Problems with a Cost-Effective Solution that Maximizes Production While Maintaining Well-Safety Requirements

**Equipment required**

- **Capillary Coil Unit**  Capillary Unit for 1/4-in. Capillary Coil 1500m di 1/4-in. OD x 0.049-in. wall thickness capillary coil; 1/4-in. pipe slips + C plate

- **BOP/riser configuration for Capillary string**
  - Stuffing box for ¼-in. Capillary String
    - 1 x 8 ft, 8 ¼-in. lubricator
    - Double BOP 8 ¼-in. dressed with ¼-in. pipe and blind rams

- **Slickline Unit**  The slickline Unit should be equipped with a drum .108-in wire

- **BOP/riser configuration for slickline operation**
  - Stuffing box 0.108-in slickline wire
    - 2 ½-in. lubricator
    - X-over to connect on top of Double BOP 8 ¼-in. coil service
Conclusions

- The continuous application of Foaming Agent through the Capillary Deliquification Safety System has brought back the productivity of the well Barbara E #45s to 100% of its productivity capability.
- The Capillary Deliquification Safety System can be installed without any change to the wellhead.
- The Capillary Deliquification Safety System maintaining the operability of a downhole safety device.
- The Capillary Deliquification Safety System can be run with just one trip using standard Rigless intervention techniques. This saves time and costs.
Thanks for your attention

QUESTIONS

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