Capillary Deliquification Safety System

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Introduction:

- Liquid loading of gas wells in mature fields is a common problem in the industry.

- A method to manage this problem is the use of surfactants as foaming agents to artificially unload the well.

- The preferred method allows automatic and continuous delivery of these surfactants.

- Safety legislation requires a Subsurface Safety Valve being operational during injection.

- Joint development between NAM and Halliburton to develop the Capillary Deliquification Safety System.
Principle:

- Typical downhole completion with Wireline Retrievable Safety valve installed in a Safety Valve Landing nipple.

- The downhole Safety Valve is operated by the control line.
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- It’s the use of the existing control line for Capillary Deliquification that makes this system unique in the industry.
How are the surfactants injected:

- Surfactants are injected into the well via a control line, Wireline-retrievable safety valve, foam injection back pressure valve, capillary tubing and a downhole foam injection valve.

- Capillary tubing's are generally 1/4” or 3/8” stainless steel run inside existing tubing or casing.

- Capillary tubing's are run into the well under pressure in a method similar to running coiled tubing into a live well bore.

- The Capillary String is providing the Surfactants to a specified point within the well bore / completion.

- The Halliburton Wireline-retrievable safety Valve with chemical Injection feature facilitates delivery of the surfactants whilst maintaining the purpose and functionality of a production downhole safety device.
How it works:

- Capillary Deliquification Safety System operates via the control line for the Safety Valve.

- When the control line pressure reaches a predetermined pressure, the Wireline-retrievable safety valve opens followed by the foam injection back pressure valve and the downhole foam injection valve.

- Use of existing control line provides a cost effective method of installing an injection system without the need to modify the wellhead.
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- The downhole foam injection valve is run into the well with coil tubing.
How it works:

- The Slip Rams close.
- Capillary tubing is cut and Coil Tubing is removed.
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- On reaching the Safety Valve Landing Nipple the keys will lock the assembly in place.
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- The assembly is set in the Safety Valve Landing Nipple nipple.
- The Wireline Retrievable Safety Valve can now be opened through the existing Surface Control Line.
- The Flapper will open.
- Control line pressure increase will open the foam injection back pressure valve and subsequently the downhole foam injection valve.
How it works:

- The Capillary Deliquification Safety System is operational and the well is protected.
Identifying the parts:

- Foam Inlet
- Conduit
- Conventional Wireline Retrievable Safety Valve
- Foam Injection back pressure Control Valve Housing
- Connector
Options:

- A Safety Valve Landing Nipple installed in a new well for eventual future Foam Injection.

- During installation, this valve has no communication with the control line.

- With a special communication tool, a hole can be punched to enable communication.

- This will give each well the option to use the capillary deliquification Safety System if required.
Features:

- The design is based upon proven Subsurface Safety Valve Technology.
- The Valve can be installed into existing completions with a suitable safety valve landing nipple profile or inside a Tubing Retrievable Safety Valve.
- Unique design allows system installation with no requirement for wellhead modification.
- Reducer nipple’s allows the use for various well sizes: 2.75” up to 5.875”.
Lessons Learned:

- Feel for running capillary.
- Injection Valve maintenance.
- Metallurgy selection.
- Foam selection with reference to corrosion.
- Perforations damaging capillary.
- Number of installations: 13
- Safety Valve size: 2.750"; 3.813"; 4.562"; 5.875"
- Safety Valve depth: 86 m till 595m
- Capillary string sizes: 1/4" x 0.035 & 1/4" x 0.049
- Capillary string depth: 1237m till 4125m
- Foam injection rates: 35 – 70 liters per day
- Gas production gains: Up to 150,000 Nm³/day
Offshore Capillary String Experience Venture Production Nederland B.V. to Prevent Halite Precipitation

- Gas well, 7”, 5½”, 5” and 4½” tubing, 5” liner
- ~3770 m deep, max. deviation 32.7°
- WRSV at ~216 m, length capillary string ~3550 m
- Perforated interval length 37 m
- Potable water injection rates 3 - 4 m3/day
- Good success on continuous water injection
  - Well produces approximately 130,000 Nm3/day
- First offshore installation in the world of its type

Way Forward
- Continuous water injection → 2nd installation by Q1 2009
- Implement continuous foam injection → in two installations by Q1 2009
- Objective simultaneously battle liquid loading & halite precipitation via use of capillary string technology

Experience to date