Gas Lift Valves Barrier Testing

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Statoil & IRIS*

- In 1982 Statoil introduced a qualification testing program for Down Hole Safety Valves
- This was the start for International Research Institute of Stavanger (IRIS)* of their third part testing for Statoil
- More than 25 years experience of testing down hole equipment is the base for gas lift valve barrier testing

* Former Rogaland Research
"Gullfaks Accelerated Production Project" - 1983.

- The current API 14a was not sufficient for the qualification requirements needed for a sub sea installed DHSV in the North Sea
- Testing of DHSV according to Statoil`s requirements resulted in:
  - Improvement of the reliability
  - Elimination/reduction of work overs
- The following companies where represented in the testing:
  - Baker
  - Otis (Halliburton)
  - Camco (Schlumberger)
  - AVA
Requirements for gas lift valves as well control barrier elements

• The Norwegian Petroleum Government:
  "An operator that wants to use gas lift valves as satisfactory barrier elements against the reservoir must consider these valves to be down hole safety valves”

• NORSOK D-010:
  "For gas lift valves to qualify as a well barrier there shall be a qualification test demonstrating the valves ability to be gas tight over an operator defined number of cycles”
Requirements for gas lift valves as well control barrier elements

• Statoil WR0534:

"The gas lift valve(s) shall together with the tubing be part of the primary barrier"
Why a qualification test program?

- As a Barrier Valve in the Tubing?
  - According to ISO 17078-2: “they are not designed nor intended to be a part of the safety system, nor to be a part of a tight shut-off pressure safety seal”
  - The gas lift valve is allowed to leak 35 std cu ft/day or 6883 ml/10min
  - Statoil requirement is: ~0.1 std cu ft/day or 20 ml/10min
Why a qualification test program?

• In Sub Sea Applications with a high intervention cost
  – Replace the need for installing a Dummy Valve
• Installed during the initial completion
  – Withstand the initial pressure test of the completion.
• Not be eroded during the unloading nor during the gas lift sequences
Valve suppliers

- Valves from the following suppliers have been tested in the period of 2005 – 2009:
  - Schlumberger, Baker Oil Tools, Weatherford and Petroleum Technology Company (PTC)
Test Facility at IRIS

Located in Stavanger, Norway
Test Facility at K-Lab
Gas Lift Test Facility – main capacities

• Back flow integrity test
  – 100 psi to 10000 psi by use of gas (nitrogen) and water
  – Bubble detection system: Visual reading by use of camera from 0 to 30 ml/10 sec (test acceptance criteria: 20 ml / 10 min)

• Unloading test
  – Test flow rate: 1.5 bbl`s /min
  – Max. during test: 3 bbl`s / min
  – Max. flowing condition: 4350 psi ~2 bbl/min
Test Program

- Back check valve is free to move from closed to open position
- Minimum amount of reverse flow and pressure required to close the back check valve
- Back check valve is water and gas tight
Test Program

- Unloading operation as in a real well
- Determine the back check valve function (open-close)
- Verify barrier integrity after a predefined circulated volume at a certain flow rate
Test Program

- Gas lift operation as in a real well
- Determine the back check valve function (open-close)
- Verify barrier integrity (gas tight) after 100 cycles
Test Program

- Similar to the Initial function test
- All tests were performed in horizontal position
Test Program Optional

- Simulate the effect of debris that may be present in the annulus
- To be performed only when the valve has been qualified
- Failing during the erosion test will not disqualify the valve
Test Acceptance Criteria

1. The back check valve shall close at a differential pressure of less than 25 psi

2. Liquid: No more than 1% reduction in the differential pressure over the hold period of 10 min

3. Gas: No more than 20 ml gas leakage over the hold period of 10 min
   The bubble rate shall not increase during the hold period

• Final qualification: Field proven – 10% of expected life time
Test findings

- Valves did not meet the Back Flow Integrity Test
- Valves had to be slammed closed to seal off
- Valves failed due to incorrect tolerances
- Valves did not behave in a consistence manner
- Valves failed also after lapping of sealing surfaces
Test findings

- Valves did not meet the Back Flow Integrity Test
- Valves failed due to incorrect tolerances (stuck check)
- Check did not seal off after lapping of sealing surfaces
- The differential pressure to keep the valve in fully open position was found to be almost 50% higher than stated by the valve supplier

Soft Seal was cut in two pieces
Test findings

- Check and spring were damaged
  - The check oscillated and rotated
- The sealing mechanism was damaged
  - Too low differential pressure across the valve
Test findings

- Valves did not meet the Back Flow Integrity Test.
- Valves had to be slammed closed to seal off - Some valves failed even though
- Squeezed soft seal
- The check had to be pushed off the seat by raising the annulus pressure to more than 250 psi

6 valves failed
Valve sealing design

• The following check and soft seal combinations have been tested:
  • One check
  • Two checks
    • With and without spring
    • With and without soft seal
    • Combinations of the above
Conclusion test findings

- Combination qualified
  - One check
  - Metal to metal sealing surfaces
Status in 2007

- A total of 8 gas lift valve designs from different suppliers were tested from 2005 to 2007
- None of them satisfied the test acceptance criteria stated in Statoil's qualification test program
  - Was the test realistic?
  - Did we have to reduce the test acceptance criteria?
Testing continued in 2007

- No revision of the test criteria was done
- A new gas lift supplier was introduced
  - 6 more gas lift valve designs were tested
- A total of 220 days has been used for testing at IRIS and 45 days at K-lab, from 2005 to 2008
Qualified valves

The following suppliers have qualified their valves

- Petroleum Technology Company (PTC)
  - 1”, 1 ½” and 1 ¾” SafeLifts
- Schlumberger*
  - 1 ½” XJR and 1 ¾” X-Lift

*At Schlumberger provided test facility.
Conclusion

Barrier qualified gas lift valves are now available to Statoil
Thank you

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