DTI - ASV

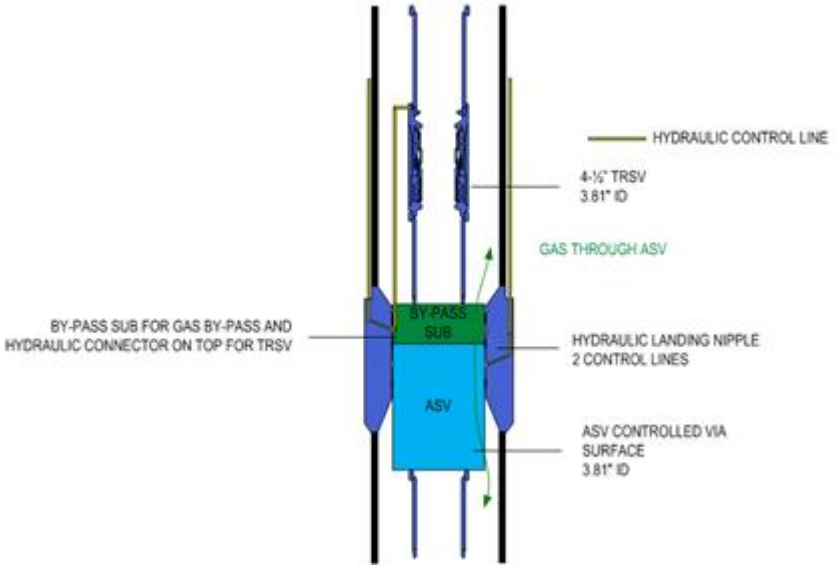
ICoTA EWIC – Annular Safety Valve Provides Sealing Integrity for use in Hydrogen Storage Wells

ASV for Hydrogen Pilot

Bi-directional sealing safety valve technology

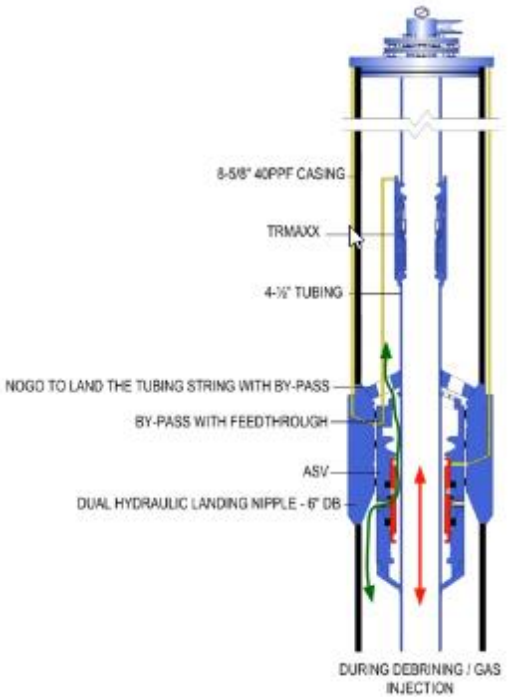
The Challenge

- SLB/Storengy required an ASV for a Hydrogen Storage Pilot project in France.
- Tubing Mounted, run into a WRSSSV Nipple with control line actuation. (No lock).
- Dual control lines to actuate the ASV, and also a TRSSSV (Supplied by SLB) run above the ASV via an integrated bypass line.
- ASV deployed 2-3 joints below surface.
- ASV will see bi-directional flow of 80-150m^3/hour brine and 190,000m^3/hour gas.
- Run on 4.5” tubing, in 8-5/8 casing to Nipple. Then 7-5/8” casing run below.
- API 14A rated. 5,000psi working pressure @ <90 C.



The Challenge

- High flow rates requested – required a unique annular closure mechanism.
  - This suited the SPSV technology DTI had developed.
- Material considerations for hydrogen use precluded typical SV alloys.
- Lots of things to do in a limited wall section.
- ID needed to be as large as possible also.
- Test and qualification parameters to be understood and agreed.
- Only 8 months to design, build test, qualify prototype and manufacture production tools!!

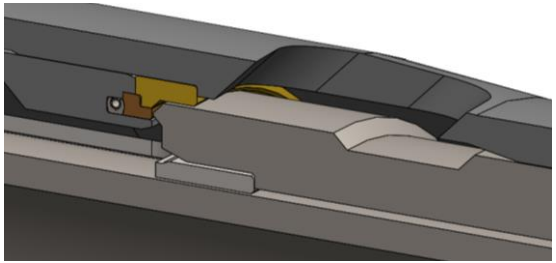


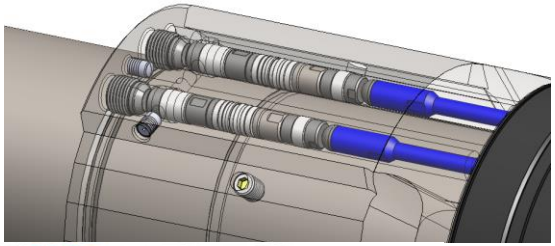
The Solution

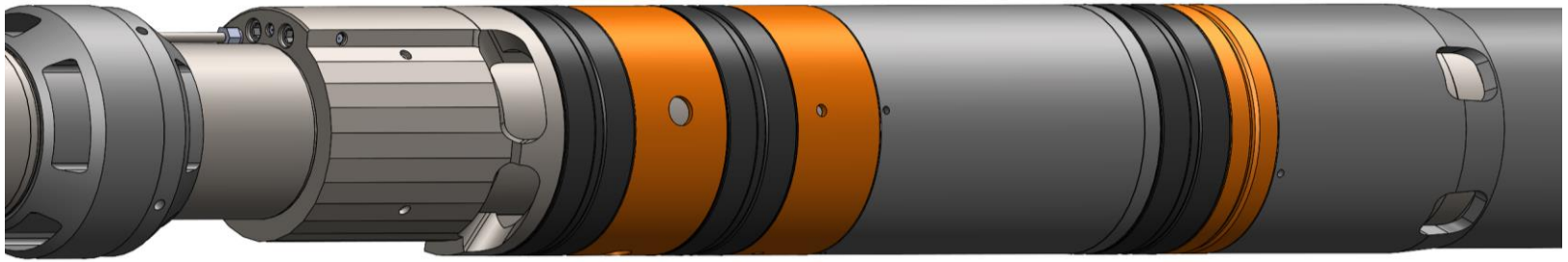
- For the high flow areas – Use DTI's annular poppet design.
- Manufacture from predominantly 4140 material with some exotic alloys for highly stress parts.
- Some new coatings tested and trialled.
- Dual actuated piston design.
- Annular sub for high flow areas to keep flow velocities below 35 fps.
- Use pre-rated V0 seal stacks for the Nipple seals into a BP6I style Nipple.
  - Considered using DTI metal to metal dynamic piston seals.
- Tested 2 designs of seal stacks for the control pistons.
  - SLB supplied design
  - Customer design for application similar to nipple seals
- Qualify to SLB supplied test program.

Design overview

- Valve mechanism –m2m.
- Piston mechanism – dual piston.
- Annular flow path - Asymmetric.
- Control line Bypass mechanism - Integrated.



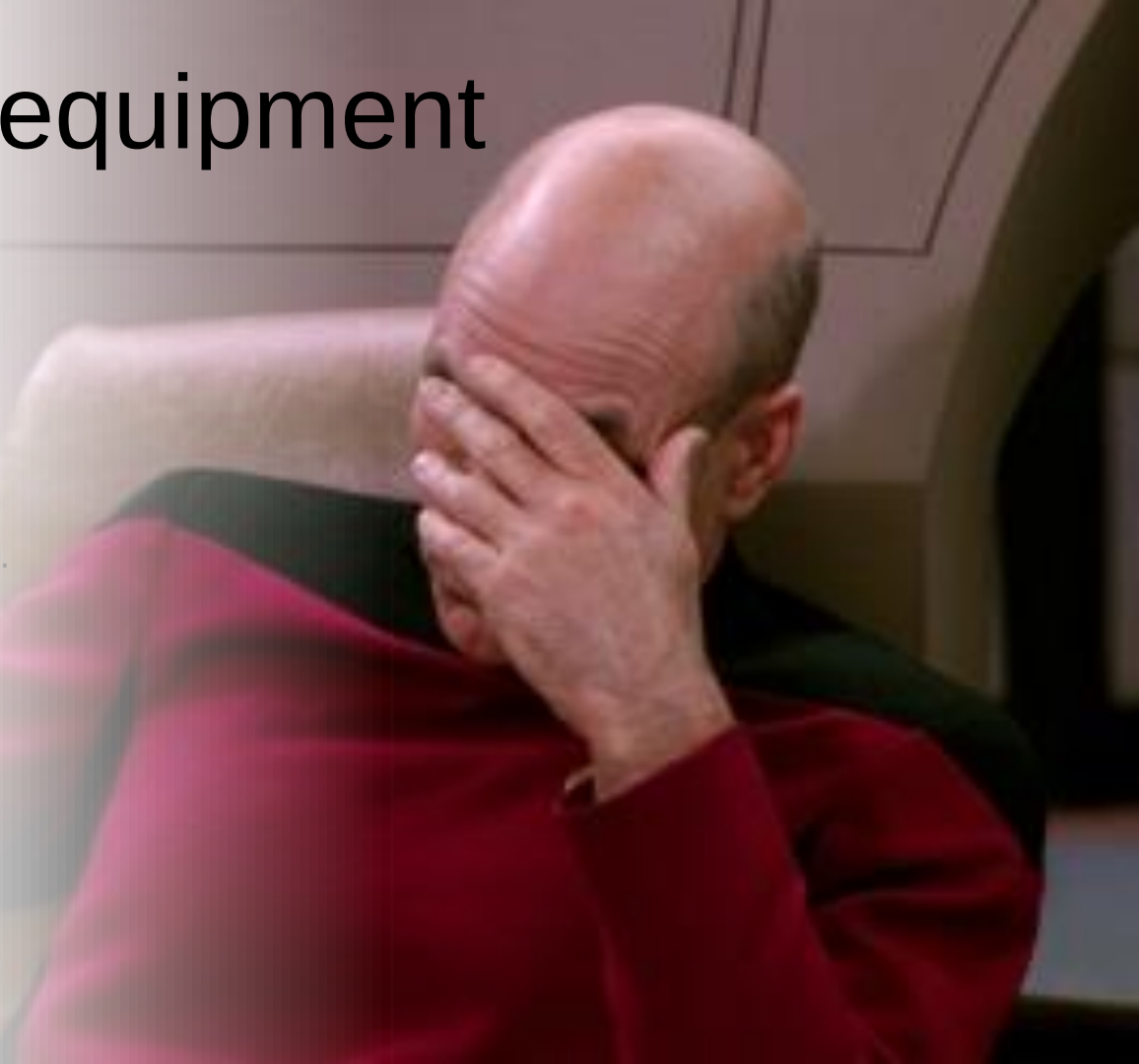




Manufacturing equipment

- Prototype dry build went fine.
- Initial testing successful
- Final cycle testing as part of annex C test – oh no a problem!

- Problem turned out to be a special coating delaminating in the piston bores.
- Worked with supplier to finalise process and add in additional steps in the coating process to suit the challenging geometry.
- Captured in the DTI coating spec and parts stripped and re-coated.
- Testing on all subsequent valves showed issue resolved!



Testing

In order to mitigate risk, DTI developed test fixtures to validate key components of the design prior to undertaking the qualification test:

- Workshop testing
  - Test Nipple created.
  - Control Piston seal Test Fixture using clamshell over port. This enabled Piston seal qualification and leak rate testing in isolation of Nipple and external seals.
  - Hydraulic testing with water.
  - Gas testing with Nitrogen. Zero bubble leakage.
- DTI Nipple Testing
  - Valve was tested into the nipple and pressure testing and retrieval.

Testing

- API Qualification
  - Valve was shipped to San Antonio for testing, prototype valve passed first time.
  - Control line test 0 bubbles over 2.5 hours.
- SLB Nipple Testing
  - Prototype valve was shipped to SLB for SIT, running into the nipple and pressure testing and retrieval – repeated 3 times.

Deployment

- All valves API 14A Annex C function tested as part of FAT.
- Valve was deployed with associated equipment successfully with no problems.
- Valve has passed the Nitrogen test phase of the Pilot and is now in Hydrogen test phase.

Thank You

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