Sval

Downhole chemical injection – the troublemaker

1 October 2024

Kristin Gjerstad Kjørsvik

Agenda

- Oda introduction

- The issues

- Asphaltene & scale inhibitor injection system design

- Challenge 1: Testing of downhole check valves

- Challenge 2: Backflow leading to risk of blockage

- Lessons learned

- Q&A

Oda PL405

Sval 70% (Operator), AkerBP 15%, DNO 15%

14km tie-back to Ula (250 km off the Norwegian coast). Water depth is approximately 65m.
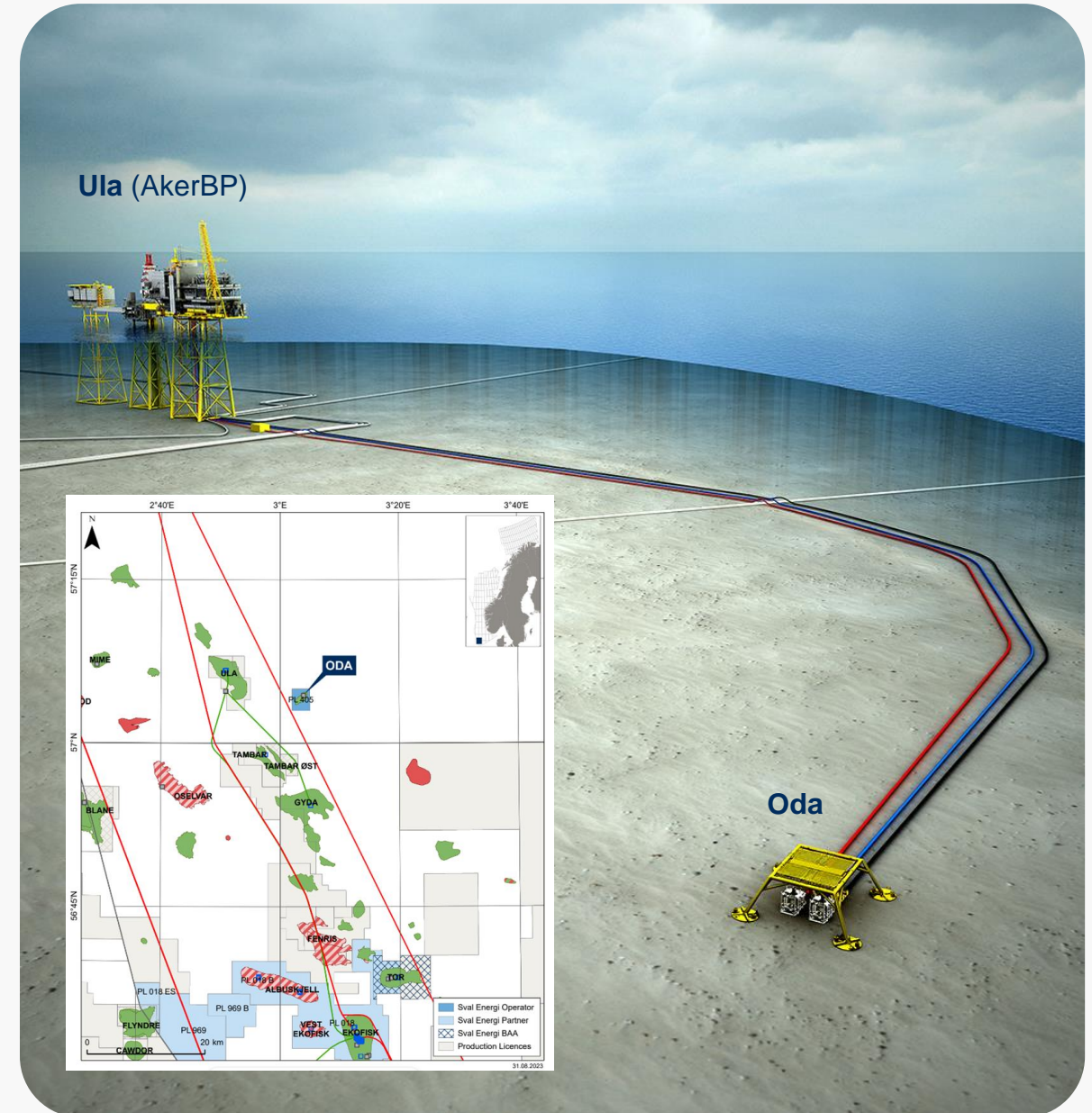
- 10 inch rigid pipe Production Flowline
- 10 inch rigid pipe Water Injection Flowline
- Umbilical with integral service line

Developed with a subsea 4 slot subsea production system (SPS) including;

- Two oil production wells (B-1 and B-3)
- One water injection well (B-2)

Production started in 2019

- B-1 were re-drilled in 2022
- Cease of production 2028

Ula (AkerBP)

Oda

The issues

Difficult to perform pressure tests of downhole check valves due to:

- High hydrostatic pressure in downhole injection line (scale inhibitor having high density)

- Temperature effect from shutting in chemical injection

Blockage of downhole asphaltene injection line due to:

- Backflow of well fluids through the check valves into the downhole injection line

- Asphaltene inhibitor being sensitive to contamination (water, well fluids, solids)

Asphaltene and scale inhibitor injection system design

Umbilical injection lines
14km - 15.88mm ID
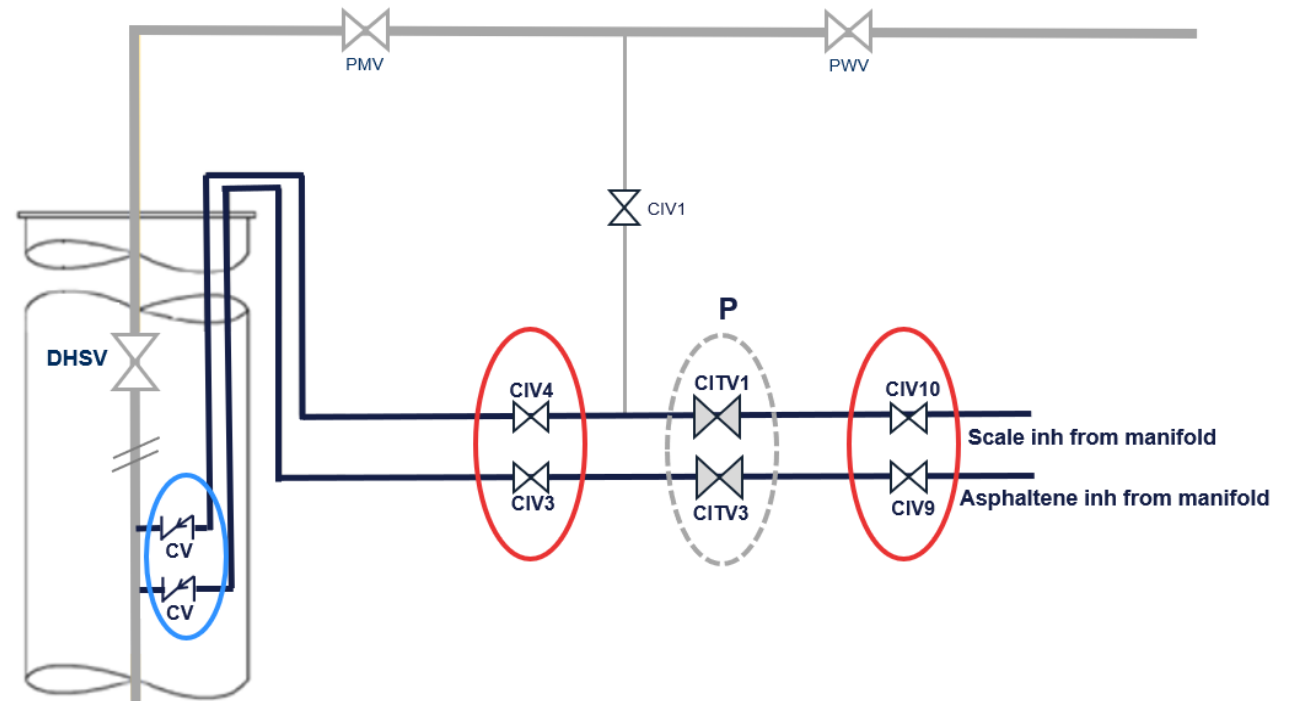
Downhole injection system
XMT valves
- Two valves in series

Downhole capillary lines
- 2500m - 6.48mm ID

Downhole check valves
- 4.8mm ID
- B-3 AH: check valve incl. filter
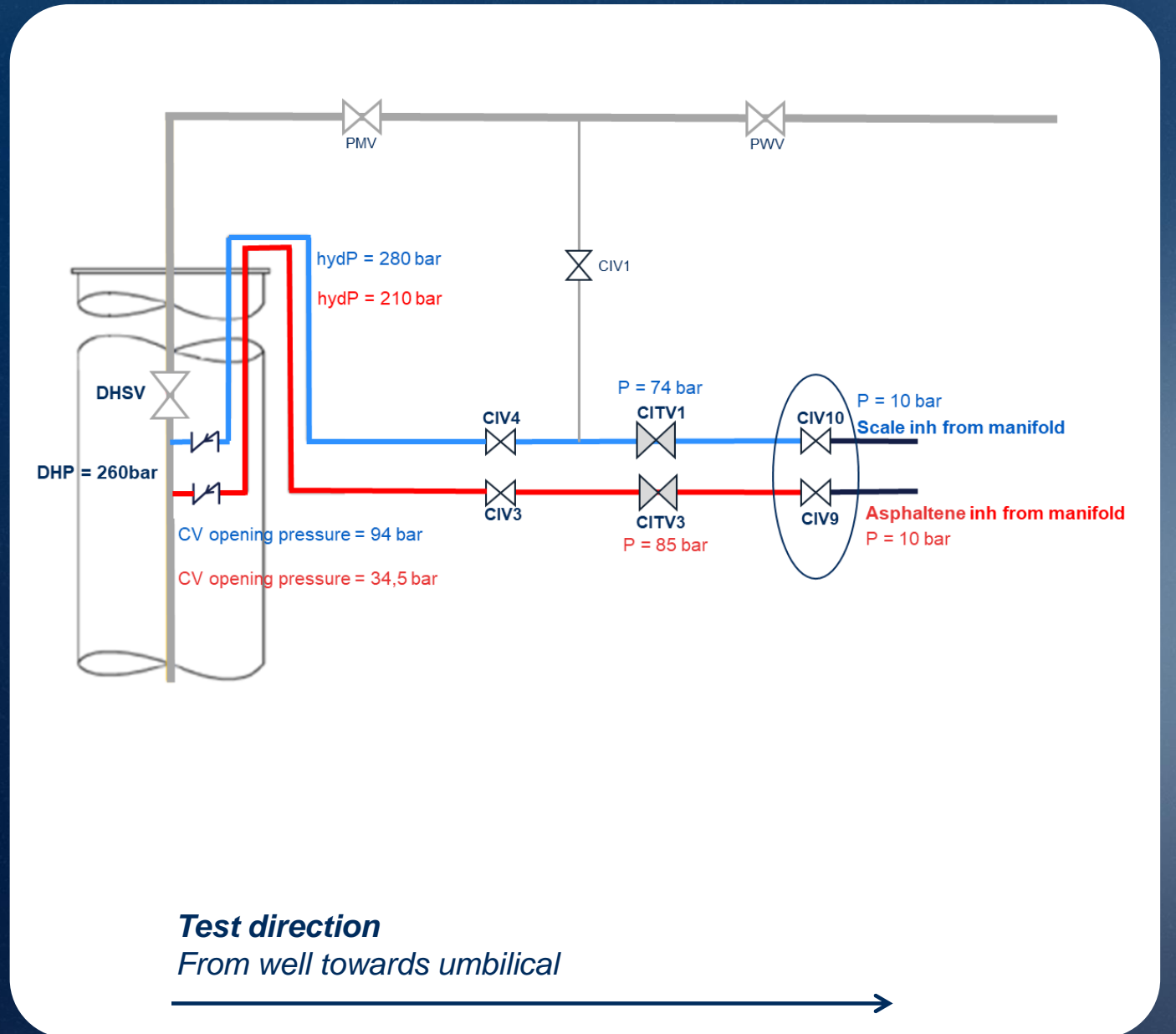- B-1 AH: check valve w/o filter

Periodic inflow testing as per NORSOK D-010.
All valves in the downhole chemical injection system are tested.

Sval

Testing of Oda downhole check valves

- High hydrostatic pressure in scale inhibitor line → not able to achieve sufficient dP over the downhole check valves

- Temperature effect from shutting in chemical injection/well → difficult to stabilise pressure

PMV

PWV

CIV1

hydP = 280 bar

hydP = 210 bar

DHSV

DHP = 260bar

P = 74 bar

CIV4   CITV1   CIV10   P = 10 bar

Scale inh from manifold

CIV3   CITV3   CIV9

P = 85 bar

Asphaltene inh from manifold

P = 10 bar

CV opening pressure = 94 bar

CV opening pressure = 34,5 bar

Test direction
From well towards umbilical
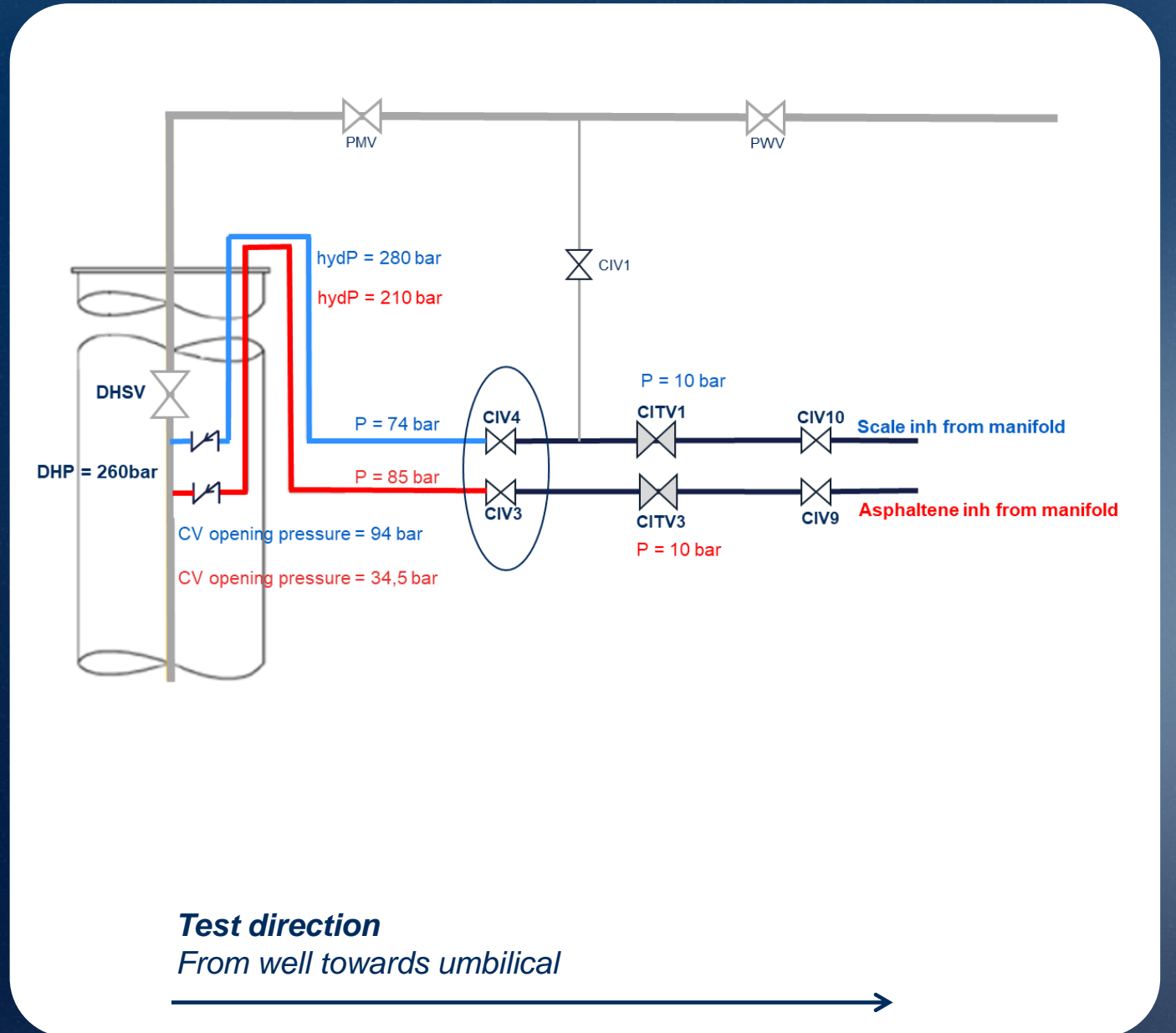
Sval

Testing of Oda downhole check valves

- High hydrostatic pressure in scale inhibitor line → not able to achieve sufficient dP over the downhole check valves

- Temperature effect from shutting in chemical injection/well → difficult to stabilise pressure

PMV

PWV

CIV1

hydP = 280 bar

hydP = 210 bar

DHSV

P = 10 bar

P = 74 bar

CIV4

CITV1

CIV10

Scale inh from manifold

DHP = 260bar

P = 85 bar

CIV3

CITV3

CIV9

Asphaltene inh from manifold

CV opening pressure = 94 bar

CV opening pressure = 34,5 bar

P = 10 bar

Test direction
From well towards umbilical
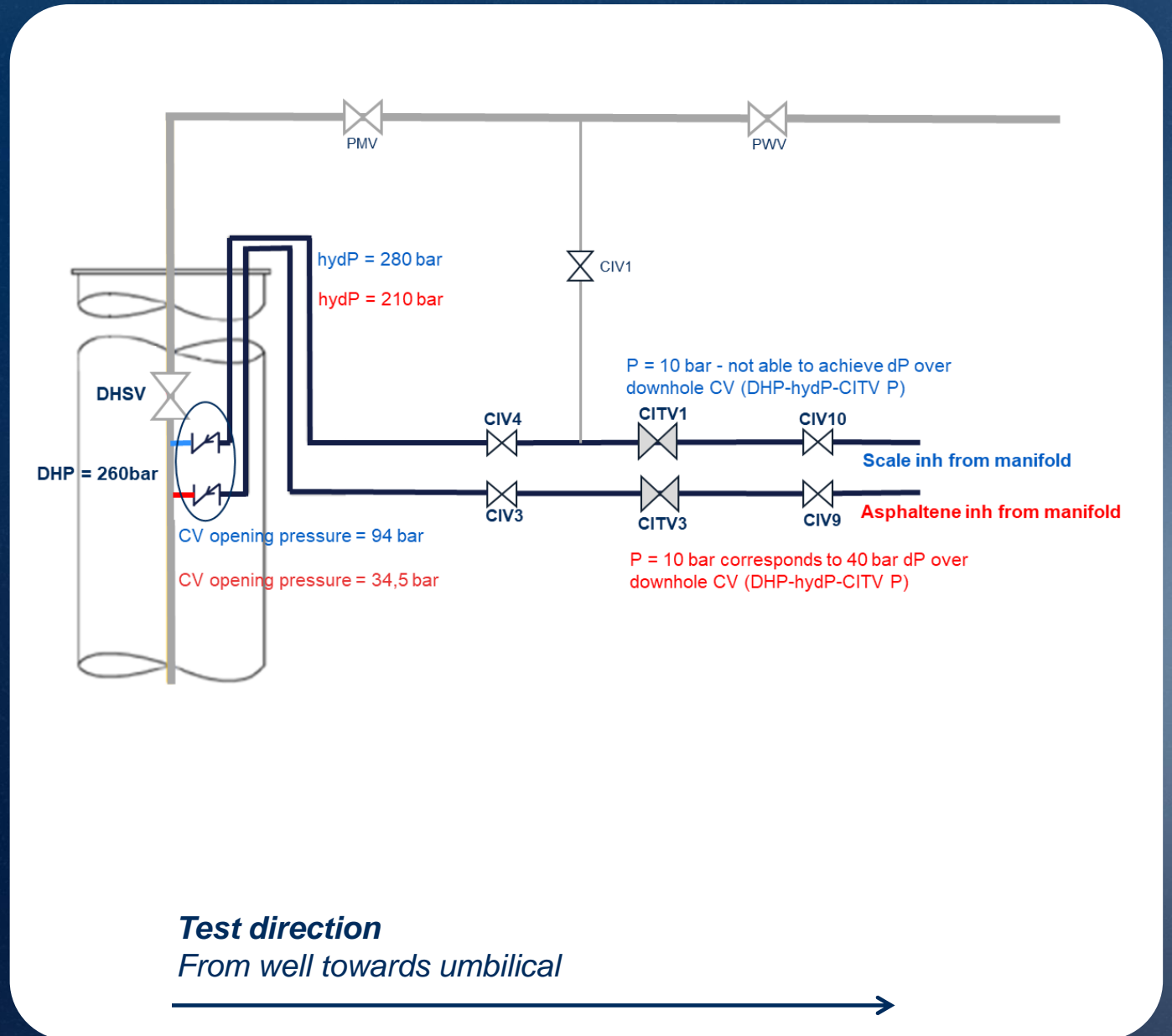
Sval

Testing of Oda downhole check valves

- High hydrostatic pressure in scale inhibitor line → not able to achieve sufficient dP over the downhole check valves

- Temperature effect from shutting in chemical injection/well → difficult to stabilise pressure

PMV

PWV

CIV1

hydP = 280 bar

hydP = 210 bar

DHSV

DHP = 260bar

P = 10 bar - not able to achieve dP over downhole CV (DHP-hydP-CITV P)

CIV4   CITV1   CIV10

Scale inh from manifold

CIV3   CITV3   CIV9

Asphaltene inh from manifold

CV opening pressure = 94 bar

CV opening pressure = 34,5 bar

P = 10 bar corresponds to 40 bar dP over downhole CV (DHP-hydP-CITV P)

Test direction
From well towards umbilical

Sval

Backflow leading to risk of blockage

Negative dP → risk of back-flow into downhole chemical injection lines
(valve test or stop in chemical injection)

January 2020
Partly blocked B1
asphaltene (AI) line
→ flush from Ula

March 2020
Partly blocked B1
AI line → use scale
inh (SI) line

May 2020
Partly blocked B1
«scale (AI)» and AI line
→ flush from vessel

February 2021
Partly blocked AI line
→ flushed from vessel
→ lost line

Produce B-1 H w/o AI
due to high water cut

Root cause analysis concluding
- Restriction in filter/check valve due
  to contaminated AI
- Insufficient flushing of the «scale inh»
  line prior to injection of AI
- Backflow identified as potential cause,
  however no signs of backflow and this
  was therefor not further investigated

October 2023
Restriction in B1 og B3
AI system observed

December 2023
Fully blocked AI line to
B1 and B3 → lost lines

Acceptable to procedure B-1 AH w/o AI
due to high water cut and B-3 AH with
continuous monotoring

Root cause analysis concluding
- Water contaminated AI
- No monitoring of dP over check
  valve or friction loss in downhole line
- Back-flow into the downhole line
- Downhole line not «flushed» after
  well integrity test

Sval

Lessons learned from Oda

Design and procedures shall take into account that there will be some leak through the downhole check valves

- Keep system at constant over-pressure
- Monitor pressure during periods where inhibitor is not injected
- Monitor friction loss in downhole injection line during injection of inhibitor
- Avoid convoluted check valve/filter sub design if possible
- Evaluate to use higher ID downhole injection line
- Evaluate to install spare downhole injection line

Sval
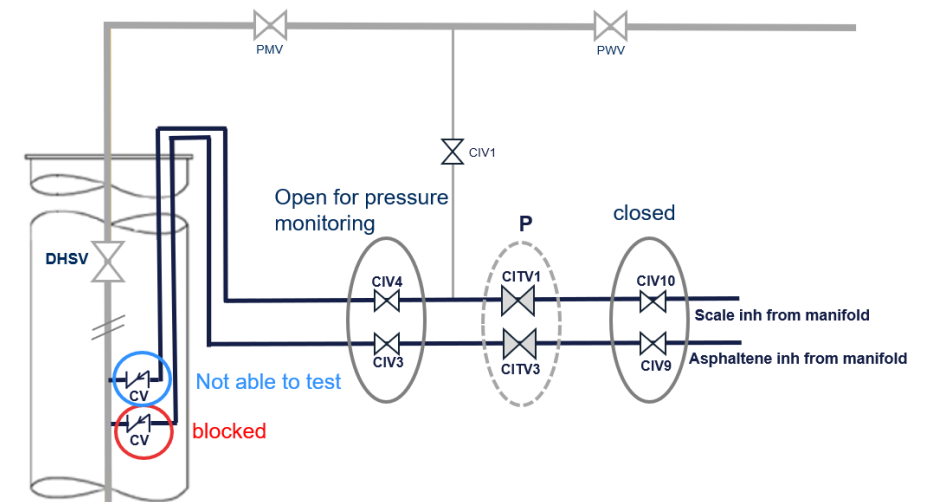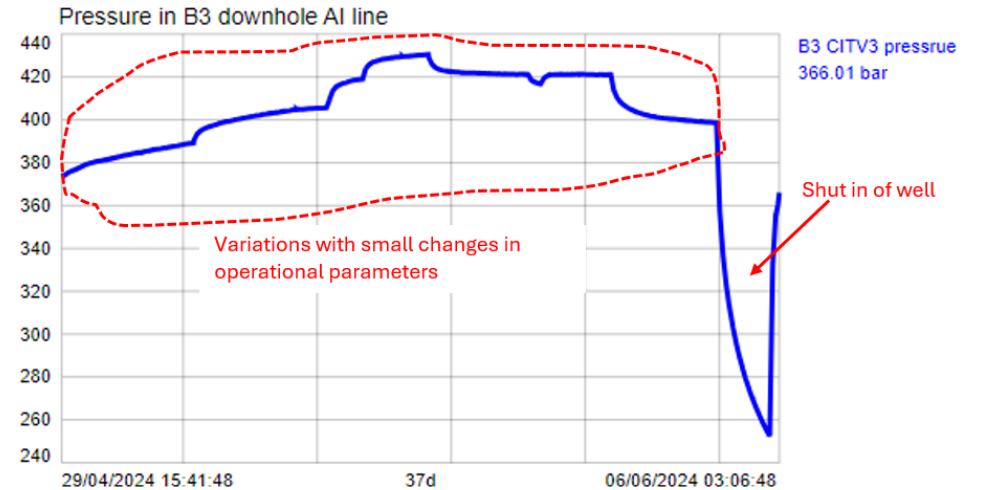
Lessons learned from Oda

Chemical quality and qualification control is critical for downhole chemical injection

- Implement strict QC specification for chemical being injected downhole

- Avoid partly filled chemical tanks to be supplied offshore

- Chemical qualification to include water tolerance and well fluid compatibility assessments

- Routine (ex. weekly) flushing/injection with inhibitor

White sticky droplets formed when mixing AI with water

Questions?