

Capillary String for Continuous Downhole Water Injection

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Previously in TEPNL

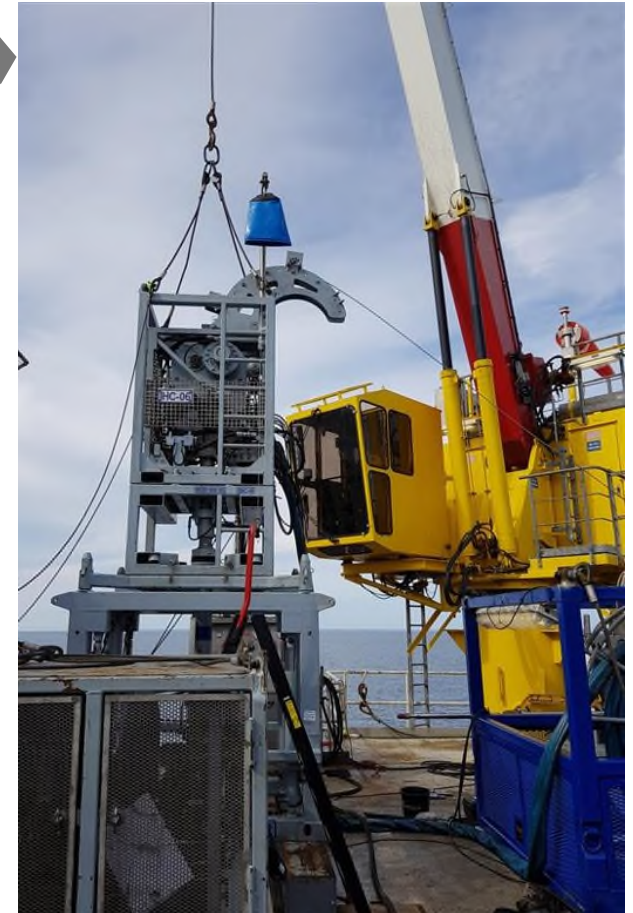
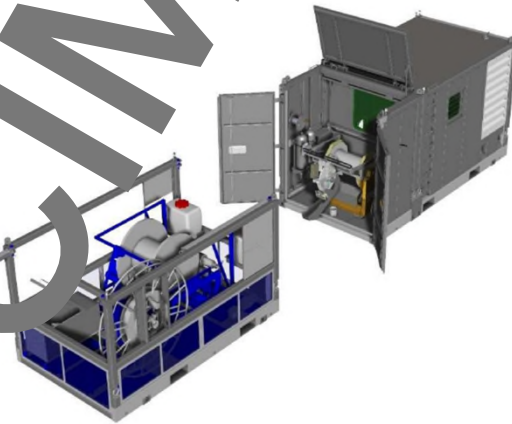


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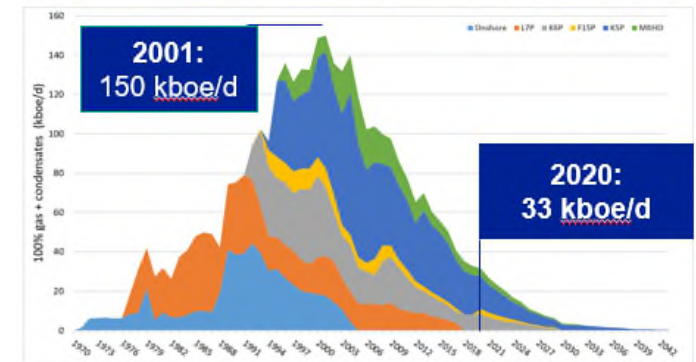
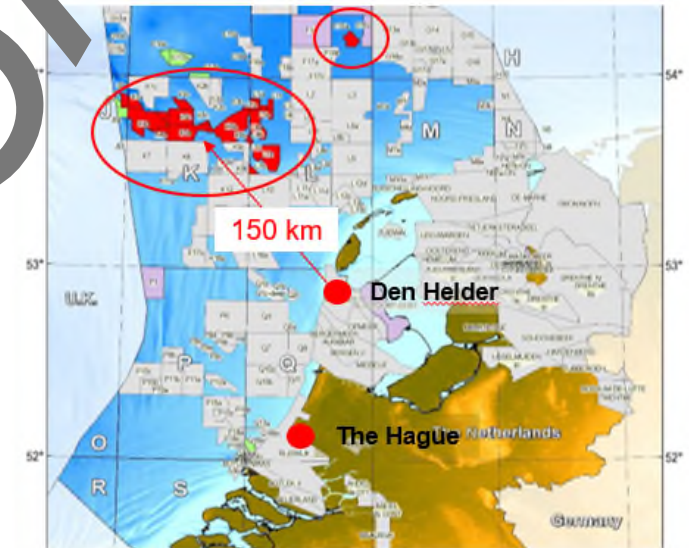
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Introduction TEPNL

- First gas 1971, peak production 2001, today around **30 kboe/d**
- **Dry gas (98.5%)**, condensates (1.5%), natural depletion (+ centralized compression)
- **Offshore:** 31 fields, 18 platforms (13 unmanned), 68 wells
- Most performance-issues related to **water**:
 - Low rates: salt issues
 - High rates: lifting, scaling, handling
- **Barrel Boosting** actions related to water
 - WHP reduction (re-route / compression)
 - Clean-outs (water / acid washes)
 - Velocity Strings (lifting & salt)
 - **Foam injection** (unloading)
 - **Capillary Strings** (water / foam)

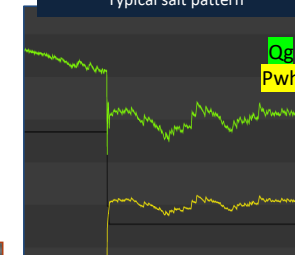


Problem definition and actions

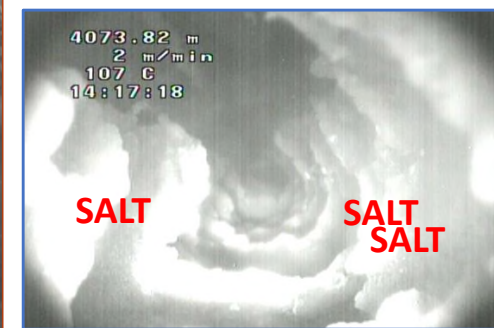
- **Salt Precipitation due to Pressure and Temperature changes in well life**
 - **Drawdown** causes evaporation
 - Production to surface gives condensation
 - Mainly around **near-wellbore/perforations** (majority of cases)
- **If little formation water, salt may deposit**
 - If a lot of formation water, max solubility is not reached, no issues
- **Detection**
 - Monitoring: **similar shaped** gas rate & flowing pressure
 - Well intervention: salt in **bailer** or on tools
- **TEPNL actions to prevent/mitigate downhole salt issues:**
 - **Cleaning:** mini-CT / capillary string with water jet (not permanent)
 - **Choking:** prevent / slow down by reducing drawdown (**lose reserves**)
 - **Shut-in:** dissolve by letting condensation water fall back
 - **Water dumping/Water wash:** remove by washing w. fresh water
 - **Velocity String:** increase flowing pressure/reduce drawdown to improve lift
 - **Capillary String (new):** keep in solution by continuous water injection



Typical salt pattern



Salt crystals (in cm)

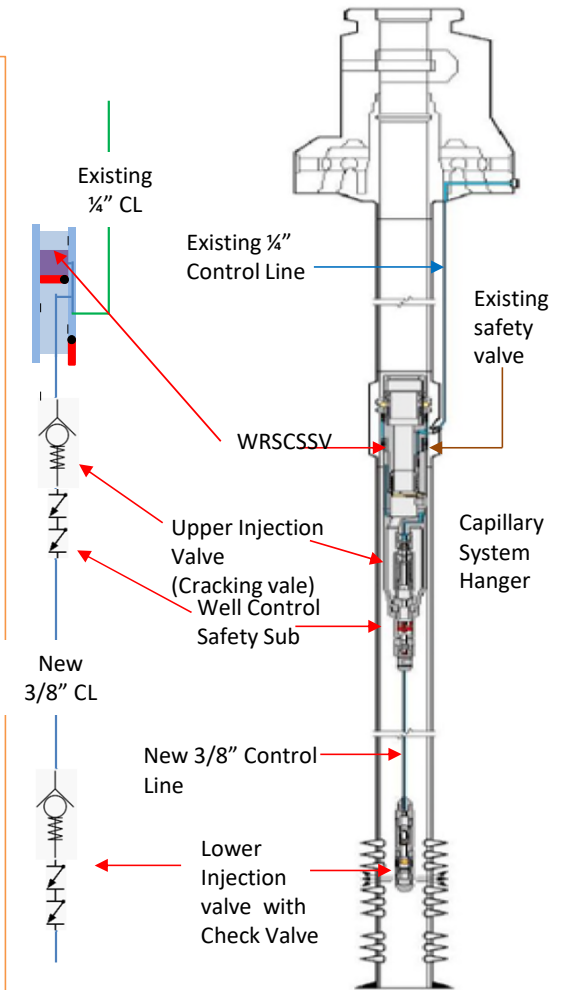


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DESCRIPTION OF CAPILLARY SYSTEM TECHNOLOGY

Capillary String System

- Permanent installation (reversible and retrievable) on an **unmanned** platform.
- Continuous water injection **1- 3 m³** per day.
- **3/8" (or 1/2")** Capillary String and utilize the existing TRSCSSV Control line
- The capillary system hanger tool lands, locks and seals in the existing TRSCSSV Landing Nipple.
- A WRSCSSV is inserted inside the capillary system hanger's internal profile and provides full wellbore isolation when the need arises. **Retrievable without pulling capillary system.**
- The capillary system **uses the existing control line to the WRSCSSV** and redirects its hydraulic (water) fluid power maintain WRSCSSV open and **inject water simultaneously** into the 3/8" Capillary String.
- If injection is not required, the hydraulic pressure can be diminished sufficiently to no longer overcome the Injection Valve's opening pressure, while still maintaining sufficient hydraulic pressure to **hold the WRSCSSV open for production without water injection**
- Required to design the opening of valves specifically to the well conditions.
 - Sufficient safety margin between opening of WRSCSSV and cracking valve when water injection not required
 - Absolute pressure at valves remains within operating parameters
 - Pressure loss of 1/4" and 3/8" lines
 - Different well condition dictates the setting of the valves



Capillary string equipment

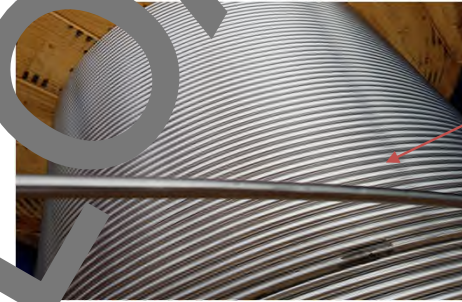


Capillary Hanger

System Tube

Cracking Valve

Quick Connect Sub



3/8" Capillary



Well Control Sub

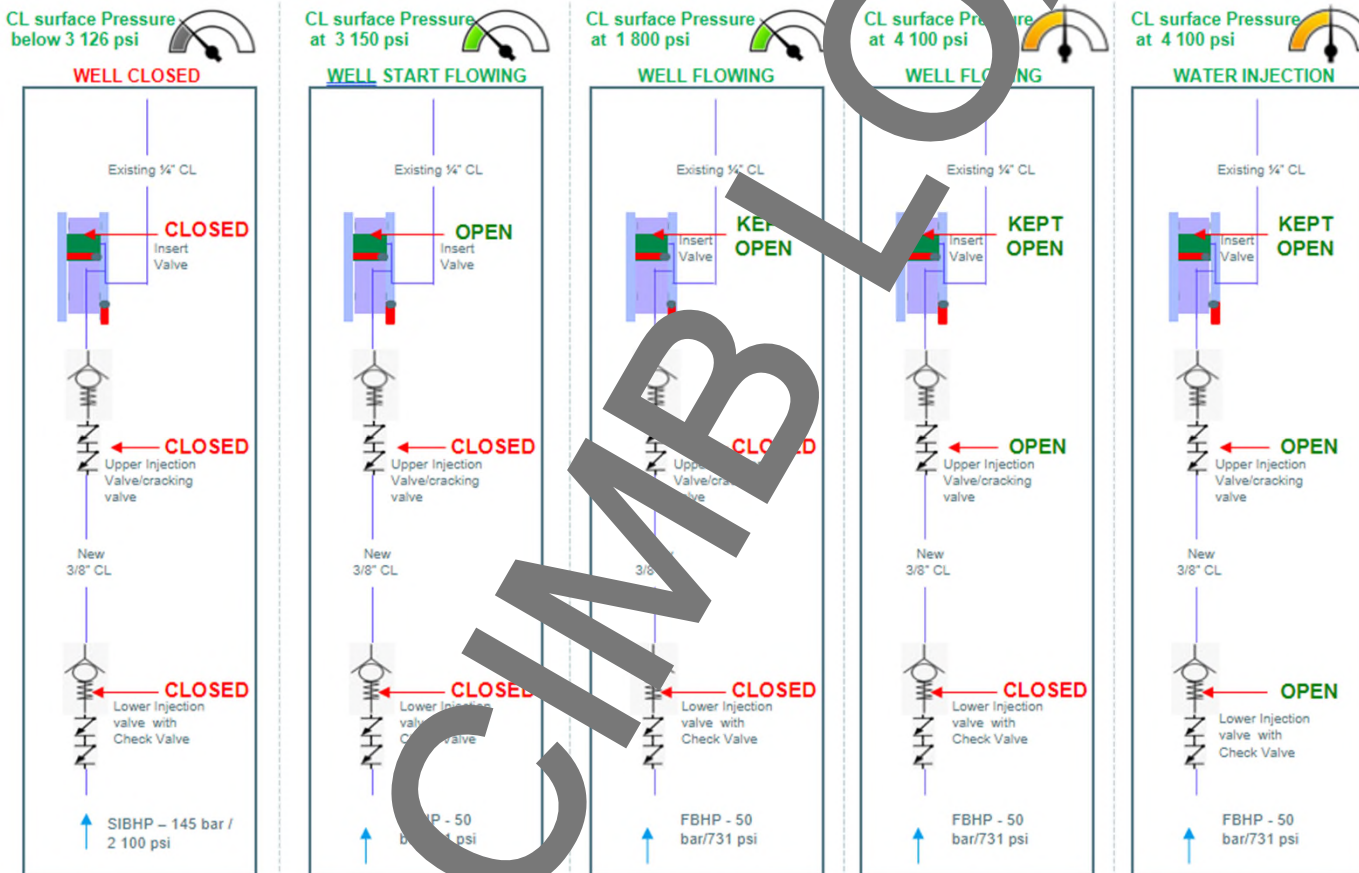
Bend Connector



Wireline Retrievable Insert Safety Valve

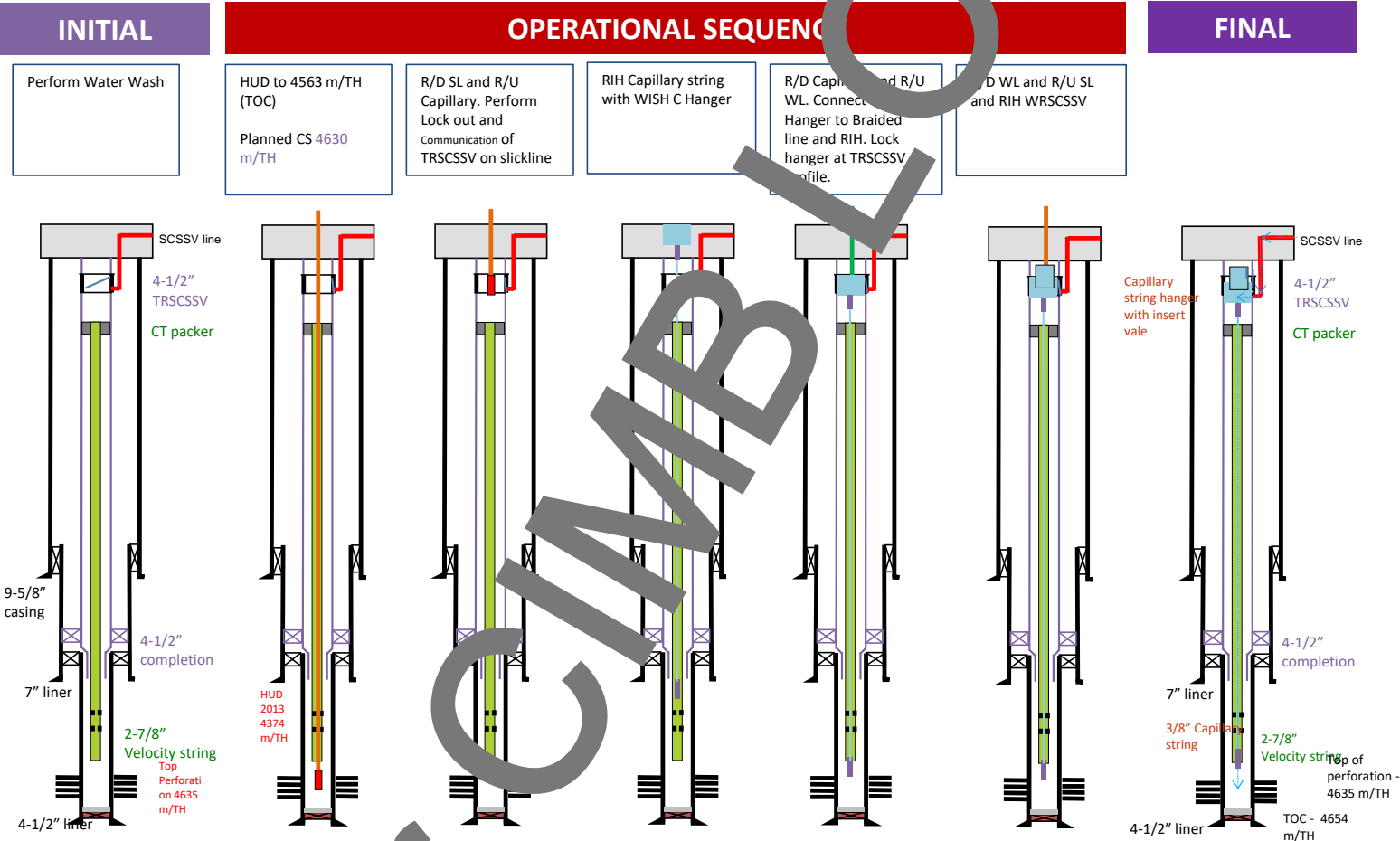
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Capillary system principle (pilot well project)

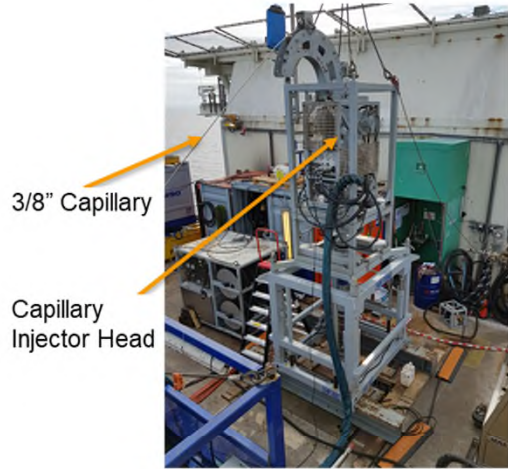


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Intervention Operation - HIGH LEVEL SEQUENCE - of the pilot well project

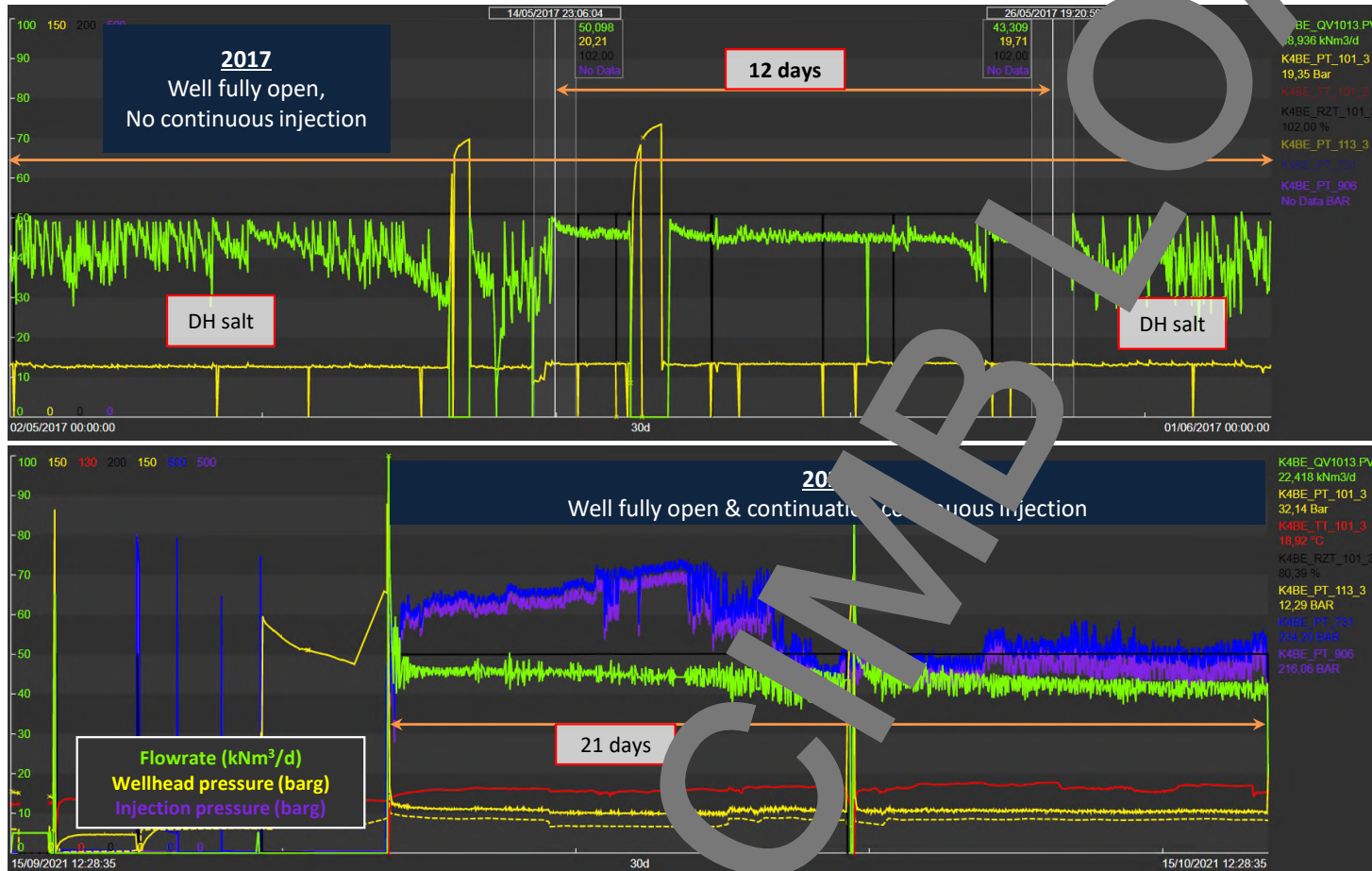


Capillary system string installation



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Pilot test results

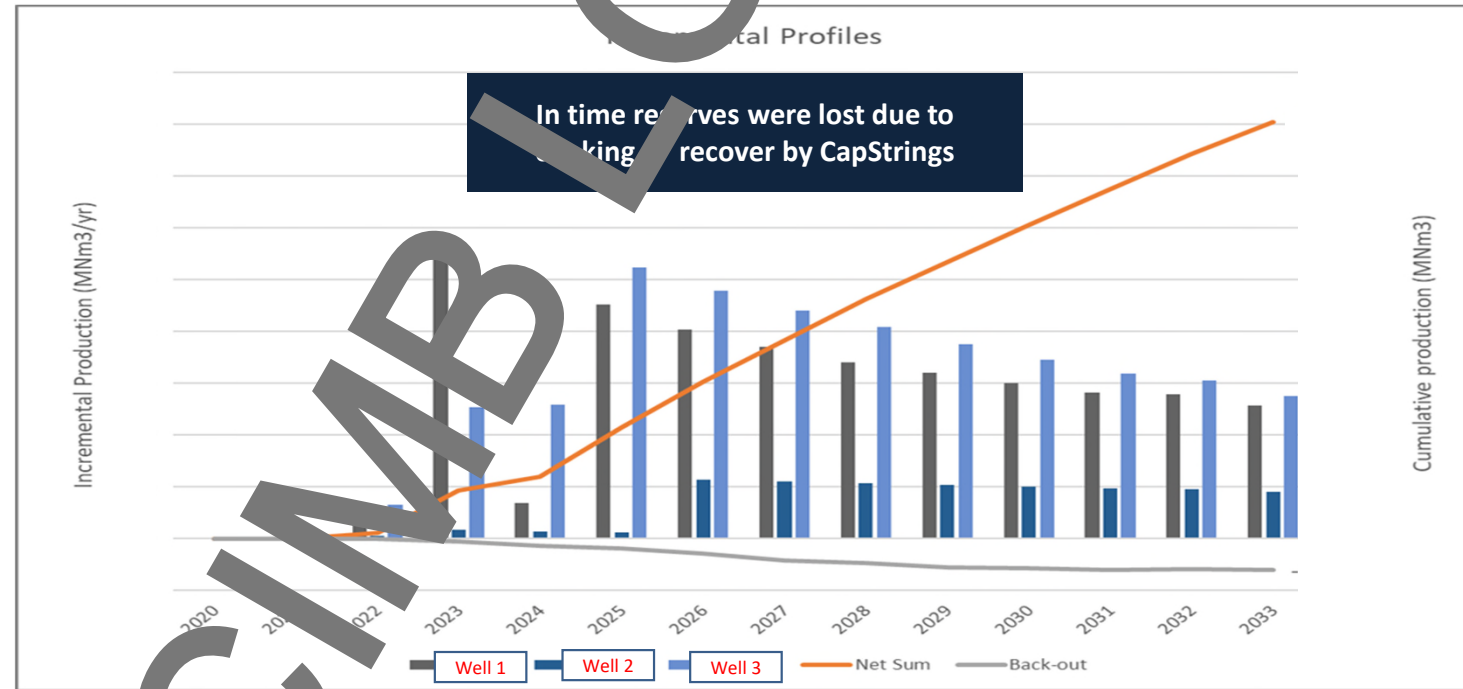


- When doing a trial: perform it on a well with low stakes!
- Important before starting: how long can well normally produce fully open without salt issues?
 - Good period of flow seen of ~12 days w/o water injection
 - **Test duration >> 12 days!**
- Successful full opening of well with stable production for 21 days:
Proof of concept!

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Way forward

- 2 other wells will be equipped with a Capillary String (bigger producers) → instant gain ~30%
- Significant incremental production expected (in range of a new well)
- Wash water will be provided from main treatment center
 - Low saline production water will be used (no oxygen)
 - Existing DEG lines between treatment center and satellites will be used



NO MORE CHOKING TO PREVENT SALT PRECIPITATION => NO LOSS OF RESERVES

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Excess sodium increases a person's risk for **HIGH BLOOD PRESSURE**, which can lead to heart disease and stroke



TOTAL ENERGIES VERSUS SALT

TEPNL has developed an innovations which ensure that salt is brought up to surface, instead of being deposited into the wells:

high-rate gas producers
Continuous downhole water
injection through Capillary String
, keeping salt in solution

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Thank You

Questions?

