Ringhorne ESP experiences
-in oil producing wells

KISTOS

Teknologidagen 2024

Presentert av Gard Munkerud

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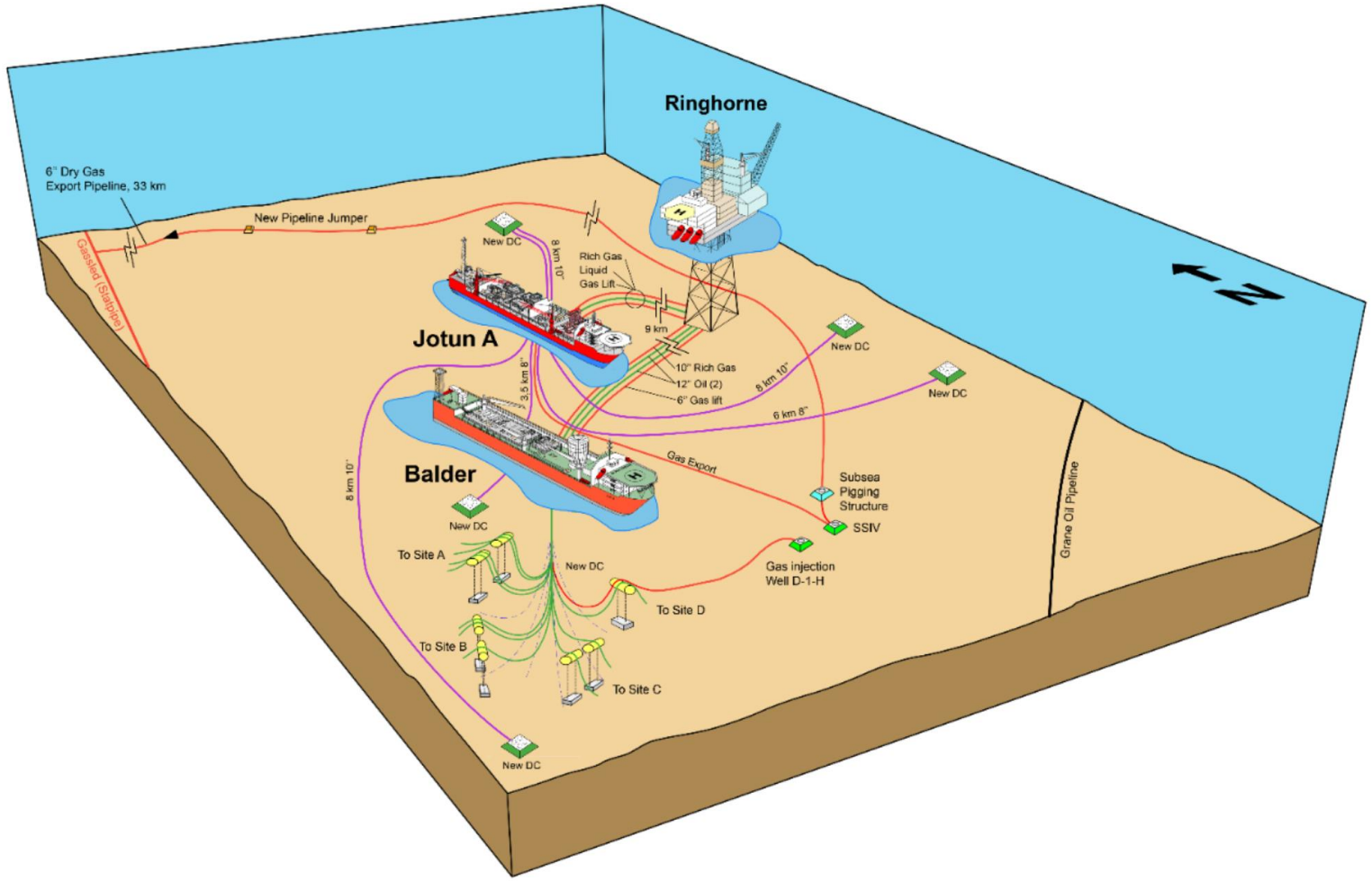
Why ESPs?



- 29 active producers on Balder & Ringhorne
- Ringhorne has no gas compression
- Balder compression capacity: 1.2 MSm3/d
- Jotun compression capacity: 2.0 MSm3/d
- 80% of compression capacity used for gas lift -> Main limitation
- ESP chosen as alternative technology for artificial lift

Overview

- Ringhorne currently has 5 ESPs in operation with 2 spare VSDs available
  - All wells are conventional oil producers with various water cuts

- Baker Hughes as pump supplier, with **dual pod ESP system** and **GLV**
  - Two ESPs installed in each well – one running at a time. GLV as back-up
  - Pump depths around 1400 mTVD / 2500 mMD

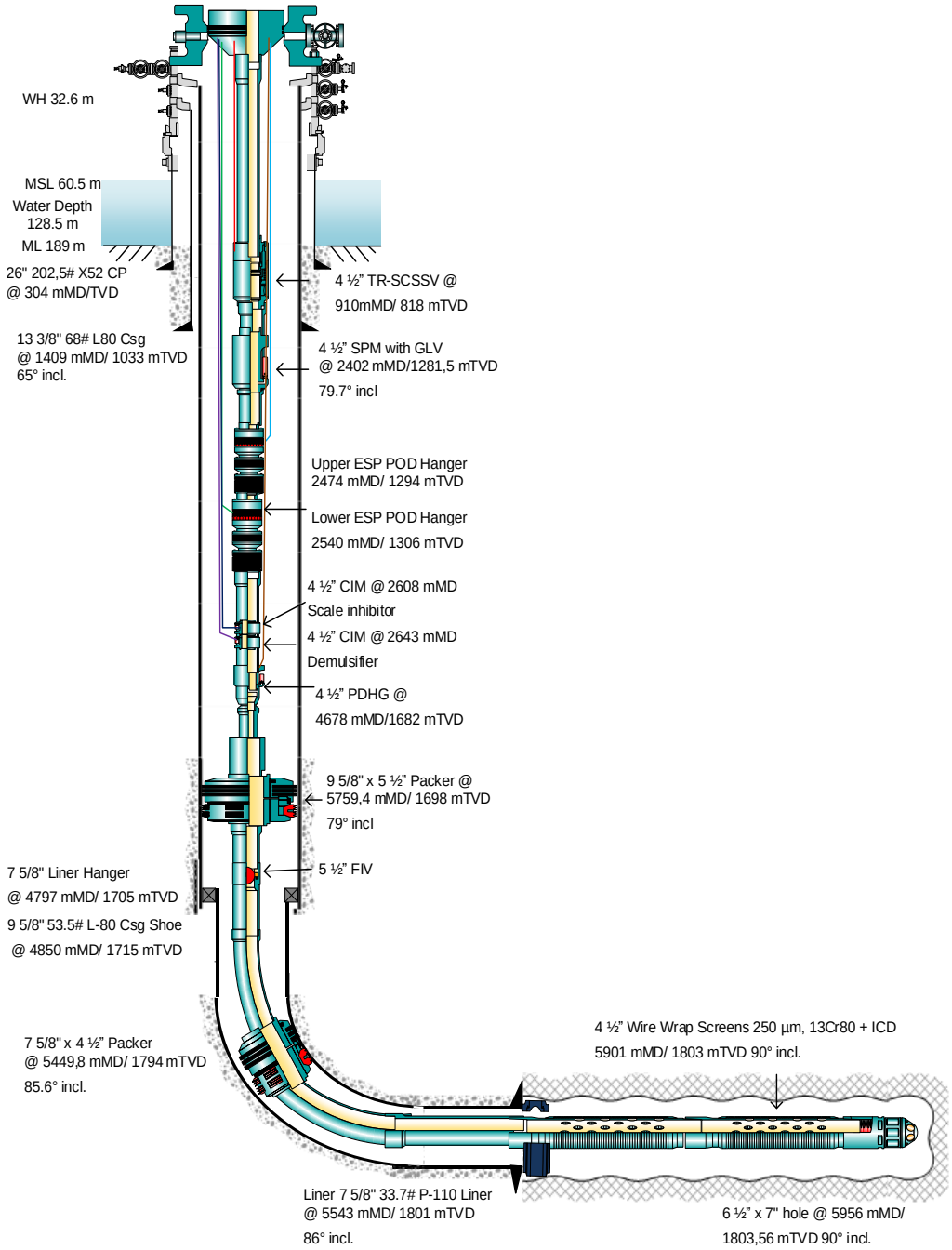
- **C-09**: Former gas lift producer. Recompleted with ESP in June 2020
  - VC155 pump. 15 kbd liquid rate

- **C-11**: Drilled & completed with ESP in April 2021
  - VC100 pump. 10 kbd liquid rate

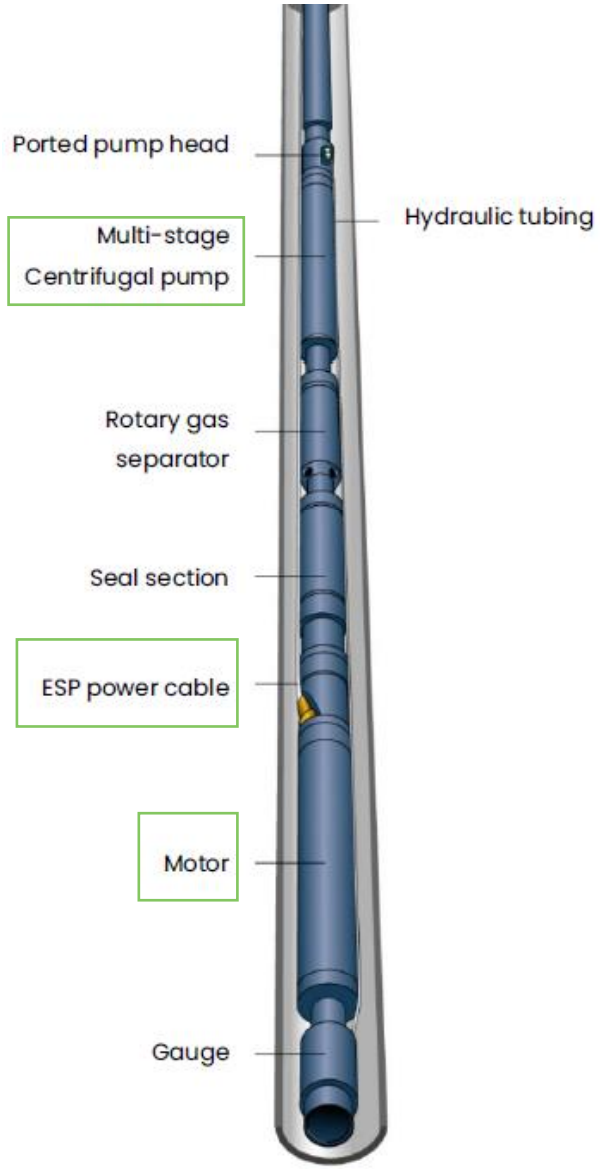
- **C-17**: Former gas lift producer. Recompleted with ESP in July 2023
  - VC155 pump. 15 kbd liquid rate

- **C-23**: Drilled & completed with ESP in Nov 2021
  - VC100 pump. 10 kbd liquid rate

- **C-24**: Drilled & completed with ESP in May 2023
  - VC100 pump w/ gas handler. 10 kbd liquid rate



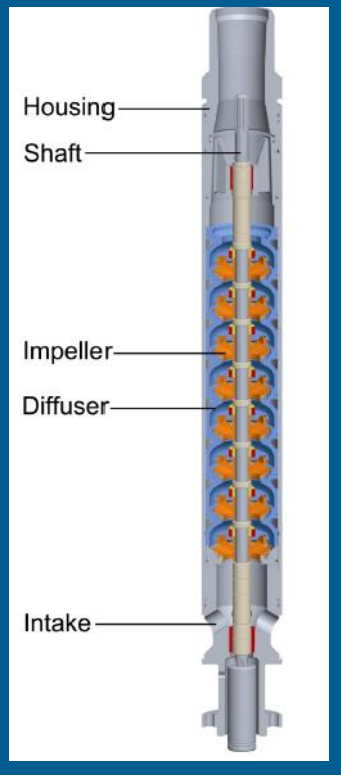
What is an ESP?

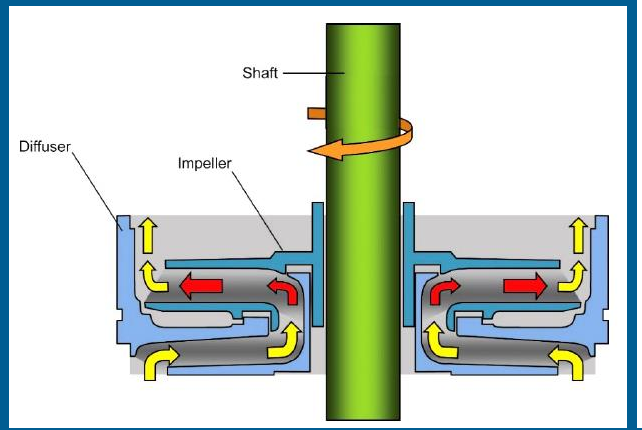


ESP pump stage: Impeller & Diffuser

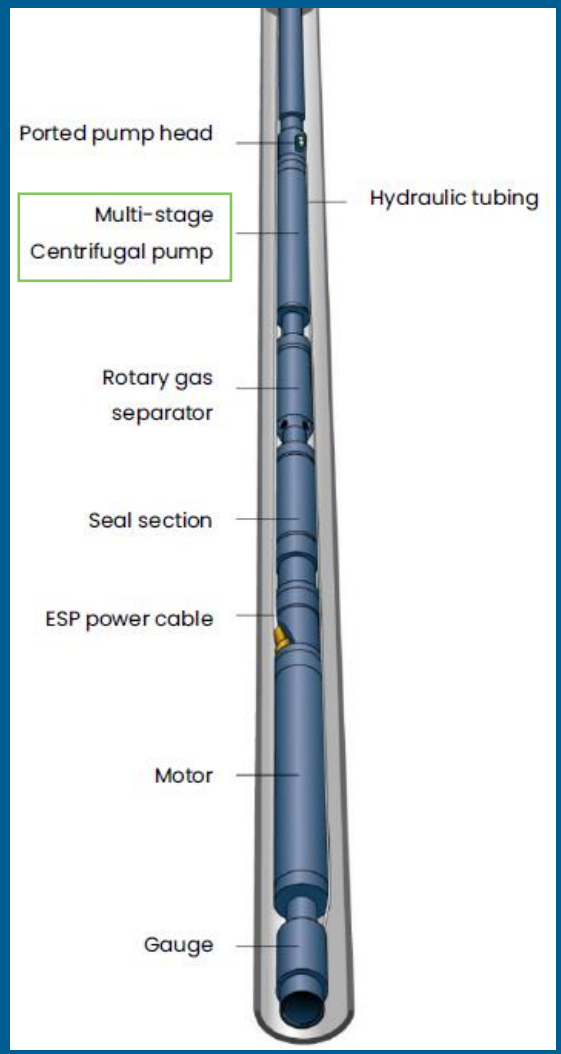
- One pump stage: Impeller and diffuser
  - The impeller rotates while the diffuser remains stationary
- The impeller pushes liquid towards the outer rim of the chamber
- The diffuser has large cross-sectional flow area to build pressure
- An ESP typically consists of 50-70 stages (i.e. little "head" is built per stage)
- Ringhorne ESPs build around 75 bar head

Two different kinds of impeller and diffuser pair





One pump stage. The shaft rotates the impellers



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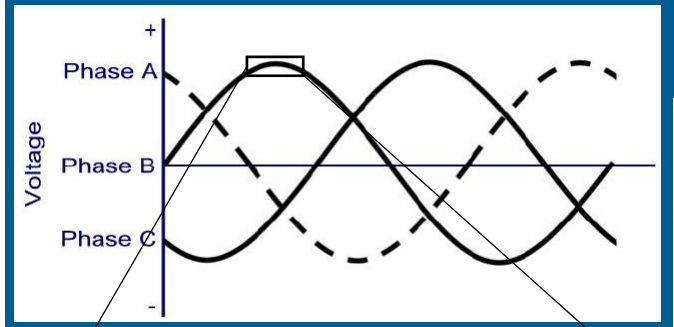
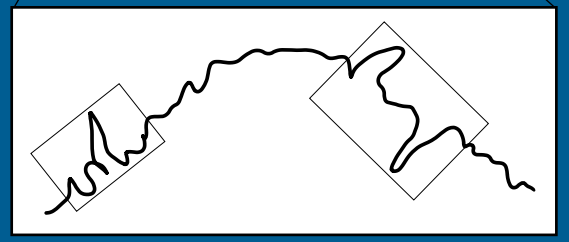
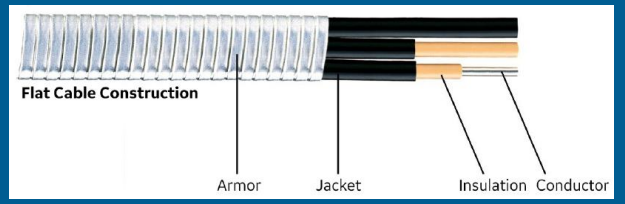
ESP: Power Cable

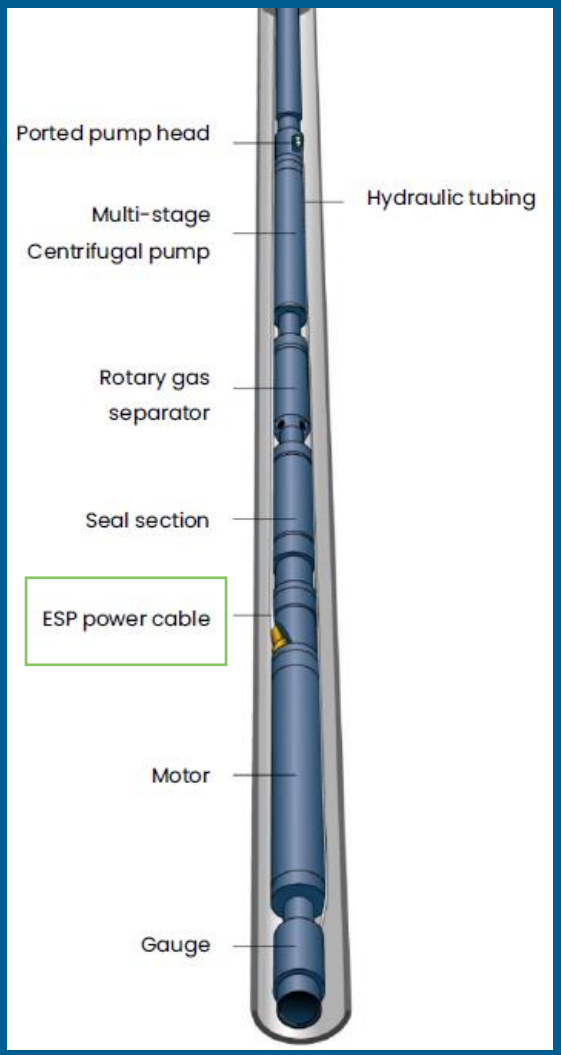
- One three-phase power cable connected to each pump
- The cable run from the junction box through the wellhead and to the ESP sitting at approx. 2 500 mMD
  - Cable is delivered on 9000' drum limiting the ESP setting depth
- Communication-on-Power provide ESP downhole monitoring and is filtered out from the power cable in the VSD by the Zenith receiver

Zenith receiver
(signal interpreter)







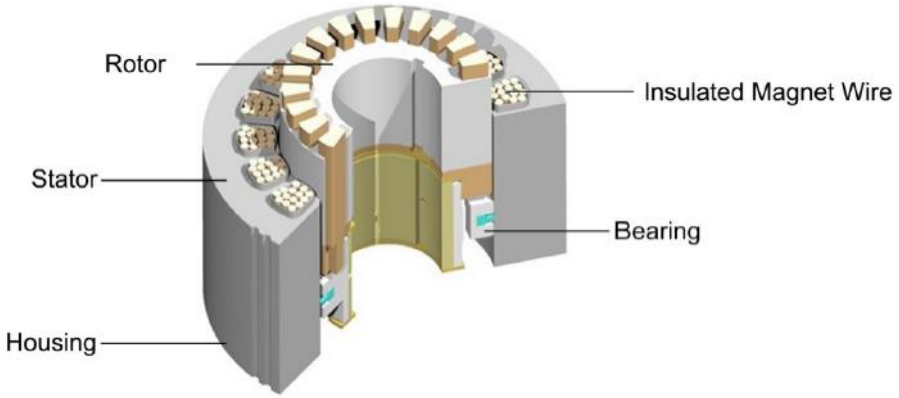


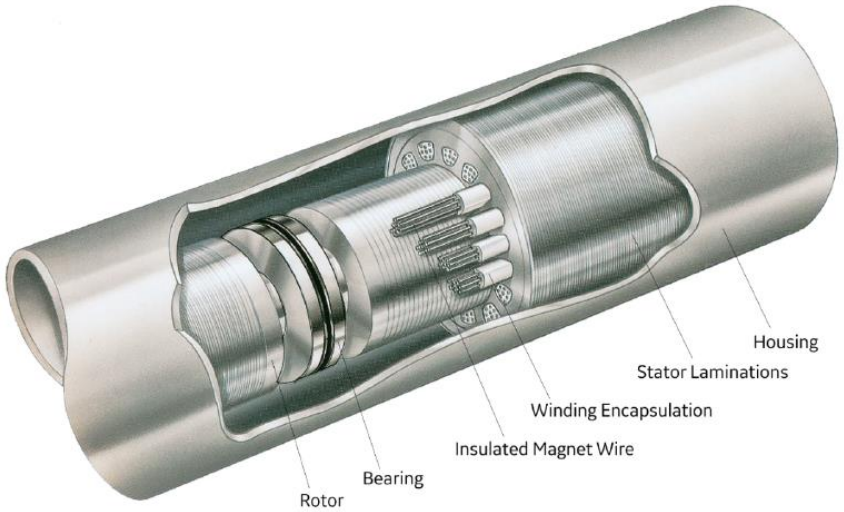
ESP: Motor

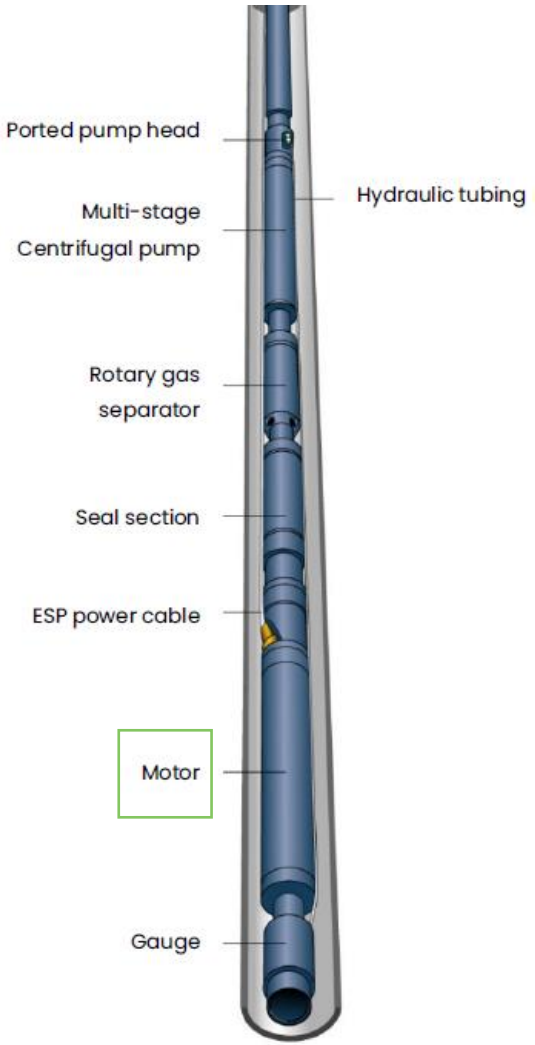
- Two kinds of ESP-motors exist – with induction motor being the most common
  - Induction motor – uses magnetic wire with no permanent magnetic field. Used on Ringhorne
  - Permanent magnet motor – uses four poles and a permanent magnet in the rotor

- The rotor is connected to the shaft which in turn moves the impellers in the pump stage

- The motor is cooled by well fluid. At Ringhorne reservoir temp is 76°C while motor temp is 100°C







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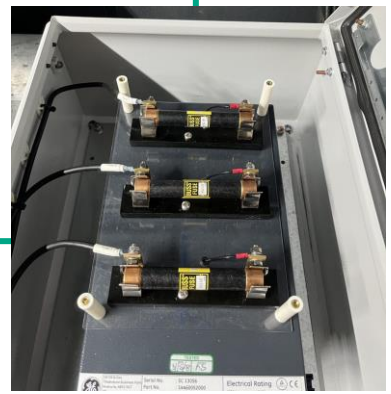
ESP Hook-up

VSD container

Turbines

VSD cabinet

Filter box w/ fuses



Junction box

Wellhead penetrator

Zenith receiver, signal interpreter

ESP

VSD = Variable Speed Drive | ESP = Electrical Submersible Pump

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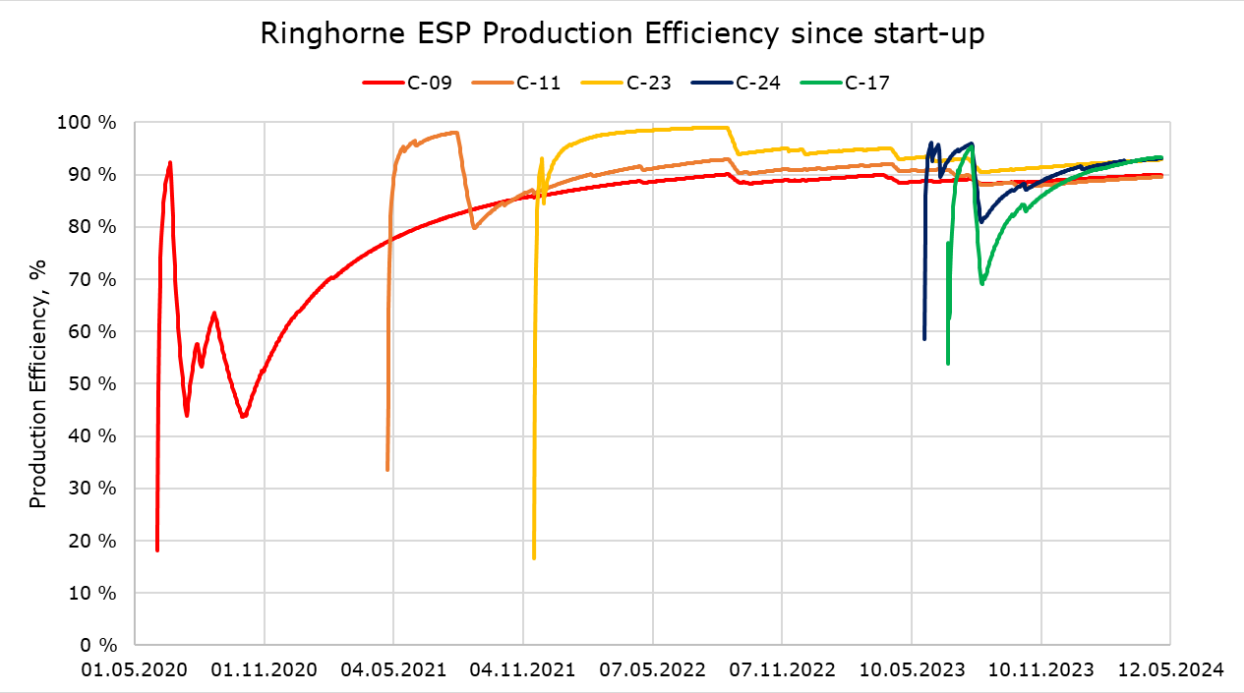
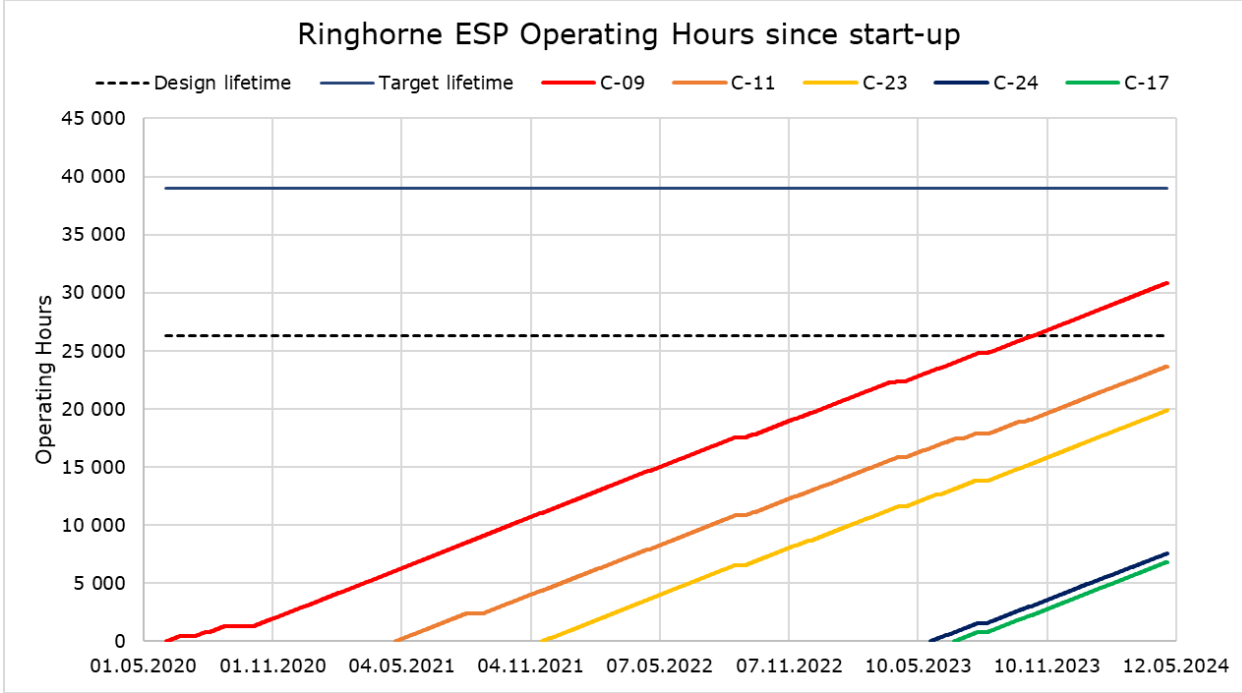
ESP Uptime & Production Efficiency

- Uptime around 90% for all ESP wells incl. scheduled & unscheduled downtime (5-10% higher than gas lifted wells)
- No ESP failures yet – still operating primary pump in all wells



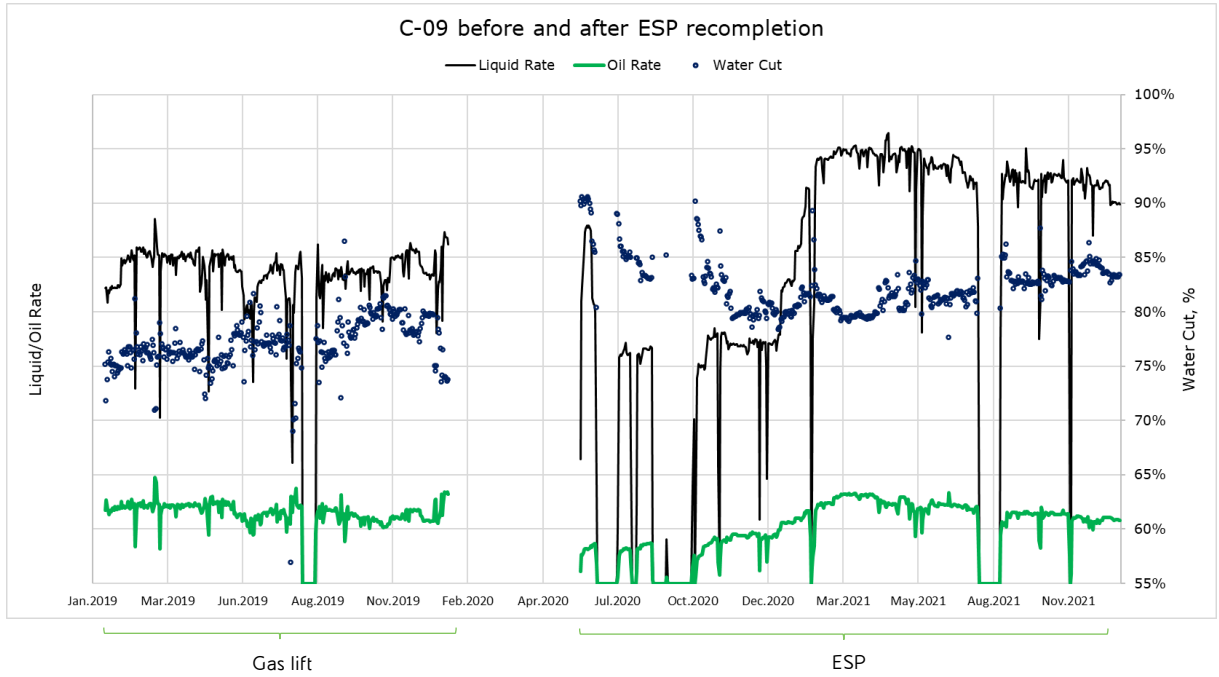


ESP vs gas lift: Workovers C-09 and C-17

C-09 – Producer from 2003 (ESP June 2020)

After ESP installation:

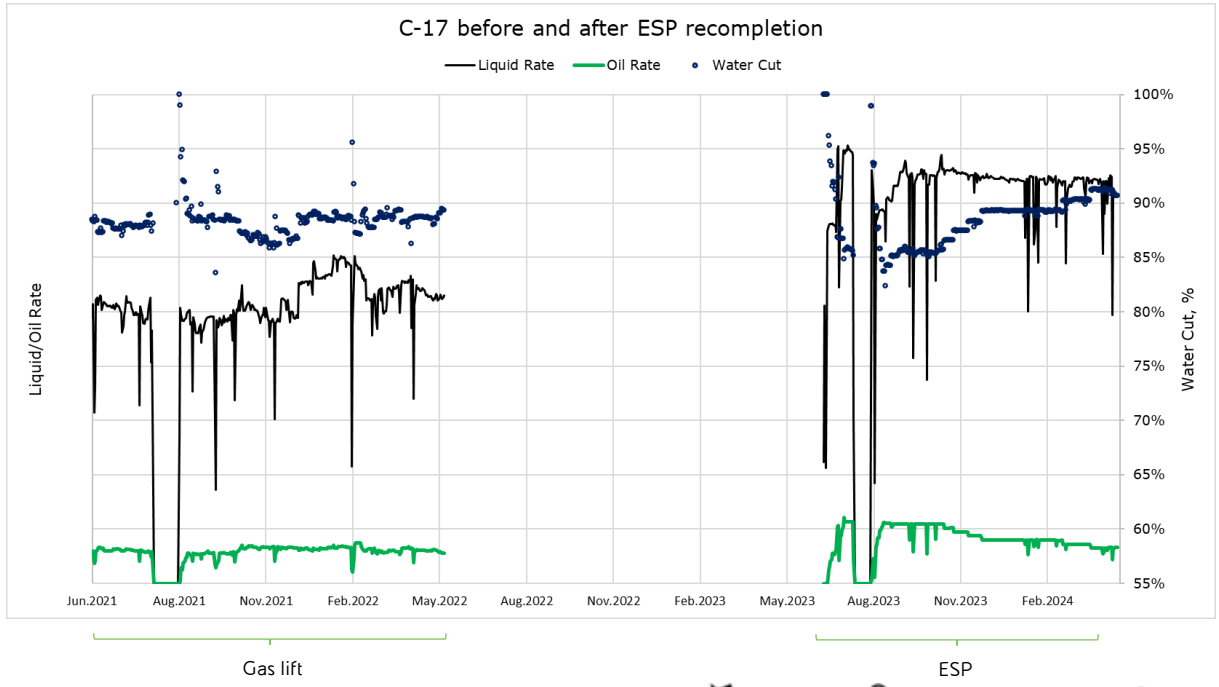
- ✓ Liquid rate increased to ESP design rate
- ✓ Water cut on trend – 80%
- ✓ Gas lift free'd up generates additional uplift on other wells
- ✓ Oil rate increased accordingly by 61 %



C-17 – Producer from 2006 (ESP June 2023)

After ESP installation:

- ✓ Liquid rate increased to ESP design rate
- ✓ Water cut around 90 %
- ✓ Gas lift free'd up generates additional uplift on other wells
- ✓ Oil rate increased accordingly by 150 %



Operational Challenges

Date	Well	Trip description
Jun 2020	C-09	Gas filled tubing at start-up due to local gas injection
Oct 2020	C-09	Trip due to topside ground fault
Jul 2020	C-09	Trip due to low backpressure in CIV. Also experienced in C-11. Requires flushing of chemical lines
Dec 2021	C-23	Trip due to faulty high voltage switch
Jun 2023	C-23	Trip due to topside ground fault
Jul 2023	C-17	No connection with Zenith receiver unit topside. Swapped receiver unit.
Jul 2023	C-17	Trip due to VSD overload
Aug 2023	-	Water precipitation inside VSD container due to cooling system fault
Mar/Apr 2024	C-24	Software incorrectly interprets gas as wellstream – only running gas handler

2018	June 2020	April 2021	September 2021	May 2023	July 2023
ESP Project launch	1st ESP (big) C-09 workover	2nd ESP (small) C-11 new well	3rd ESP (small) C-23 new well	4th ESP (small) C-24 new well	5th ESP (big) C-17 workover

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Some reflections…

Skill? + Luck?

- Incentive contracts with Baker Hughes as «One stop shop». Continuous operational support
- Close collaboration with subcontractors such as ABB (VSD provider) and Honeywell (software)
- The system is very protective, and probably *too* protective (designed to be user independent)
  - Little input from control room – generally only pump frequency and chemical injection rates

- *… Ringhorne ESP strategy going forward*