Power Study and Tailored Solution for High H₂S Environment Extends ESP Run Life in Douglas Field in the Irish Sea

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Introduction

Douglas Field
- Located in the Irish Sea, 23 Km from North Wales and England coastlines.
- Discovered in 1990, production started in 1996.
- Triassic sandstone reservoir at 2,400ft TVD.
  - Low abrasives and temperatures.

Completion details
- ESP was selected as the Artificial Lift method.
- Target run life was set at 2-3 years.
- Upper completion installed with bypass system.
Initial ESP Performance

1995-1999 Performance

- First ESP installed in July 1995.
- First ESP started in December 1995.
- ESPs in Douglas initially struggled to achieve the 2-3 target run life.
- Failure analysis and action was required to improve ESP run life.
Failures Before 1999

- A majority of failures were electrical related, distributed among different components.
- Clean oil found with no signs of well fluid contamination.
- Signs of arcing found on the motor stator and rotor.
- \( \text{H}_2\text{S} \) intrusion found inside motors and protectors.
Power Quality Study Performed in Douglas

Electrical Analysis

- Analyze the total harmonic distortion generated by the PWM VSDs in the load side.

- System frequency response test conducted to check for excessive voltage levels.

- Check total harmonic distortion at the line side.
Power Quality Study Performed in Douglas

Challenges Identified

■ Harmonic peaks detected around multiples of the carrier frequency. Harmonics in the band from 2 to 9 kHz are amplified.

■ Frequency response analysis confirmed a natural resonance in all wells in Douglas between 5.7 and 6.8 kHz.

■ A gain of 17 dB (7.1 times amplification) was noted in the resonant frequency. Voltage overshoot equals to 6.99kV.
Power Study Results

- **Challenge** – The VSDs used in Douglas do not allow increasing carrier frequency. During testing, limited benefits were obtained by changing the operating frequencies.

- **Solution** – apply load filters to change the resonant frequency and adjust gain by including dampening resistors.

- **Result** – Gain at the motor terminals reduced to 4dB. Voltage overshoot reduced to 4.64kV.
Tailored $\text{H}_2\text{S}$ Solution

- Signs of $\text{H}_2\text{S}$ intrusion was noticed during equipment dismantle. The decision was made to customize the ESP equipment to increase reliability in sour services.

- Metallurgy improvement:
  - Elastomers upgraded from HSN to AFLAS.
  - Trim upgraded to Monel and Inconel.

- Introduction of tandem protectors, with $\text{H}_2\text{S}$ Scavenger protector:
  - Sacrificial parts to delay $\text{H}_2\text{S}$ attack at the magnet wires.
  - PEEK coated high load bearings.
  - Replacement of elastomer shaft seal with metal bellow shaft seals.
Results

ESP Reliability Comparison

- ESP performance increased considerably after the introduction of the load filter and severe service protectors.

- 18 ESP systems failed in the field between 1999 and 2018. 14 electrical, 2 mechanical, 2 reservoir.

- Douglas field is now seeing wear-out failures instead of premature failures.

ESP Reliability in Douglas

Days

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

300 600 900 1200 1500 1800 2100 2400 2700 3000 3300 3600 3900 4200 4500 4800 5100 5400

Weibull - After 1999

Weibull - Before 1999
18 Year ESP Run Life Achieved

- ESPs initially struggled to reach the target run life of 2-3 years.
- Load filter installations eliminated the premature electrical failures. Scavenger protector for H₂S production increased intrinsic reliability of the ESP system.
- Strong partnership between operator and ESP supplier allowed outstanding ESP run lives to be achieved in Douglas field.
Acknowledgements / Thank You