CASE STUDY

Schlumberger

Robust ESPs Handle Rapid Production Decline and High Gas Content for Chesapeake Energy

Flexible ESP technology and Lift IQ service increase run life by 181% despite solids, high gas ratio, and declining production in Oklahoma field

CHALLENGE

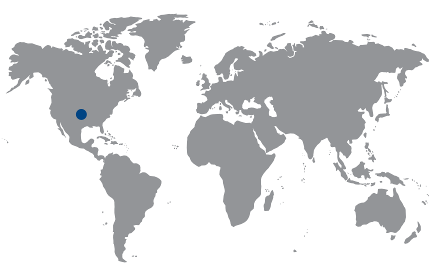
- Maintain ESP uptime despite declining, solids-laden, multiphase production with high gas-to-liquids ratios (GLR).
- Accelerate production without significant effect on lifting costs.

SOLUTION

- Deploy abrasion-resistant compression pumps to handle both sand and wide variations in production.
- Manage the variations in GLR with MGH* multiphase gas-handling system and VGSA* Vortex* gas separator assembly.
- Monitor performance with Phoenix xt150* high-temperature ESP monitoring systems.
- Optimize pump performance, uptime, and run life using Lift IQ* production life cycle management service.

RESULTS

- Increased average ESP run life by 181% (118 to 332 days).
- Handled increases in GLR up to 243% and production declines up to 94%.
- Increased cumulative liquids production in one well by 16% compared with an offset produced using ESP and gas lift, and by 55% compared with an offset modeled with only gas lift.



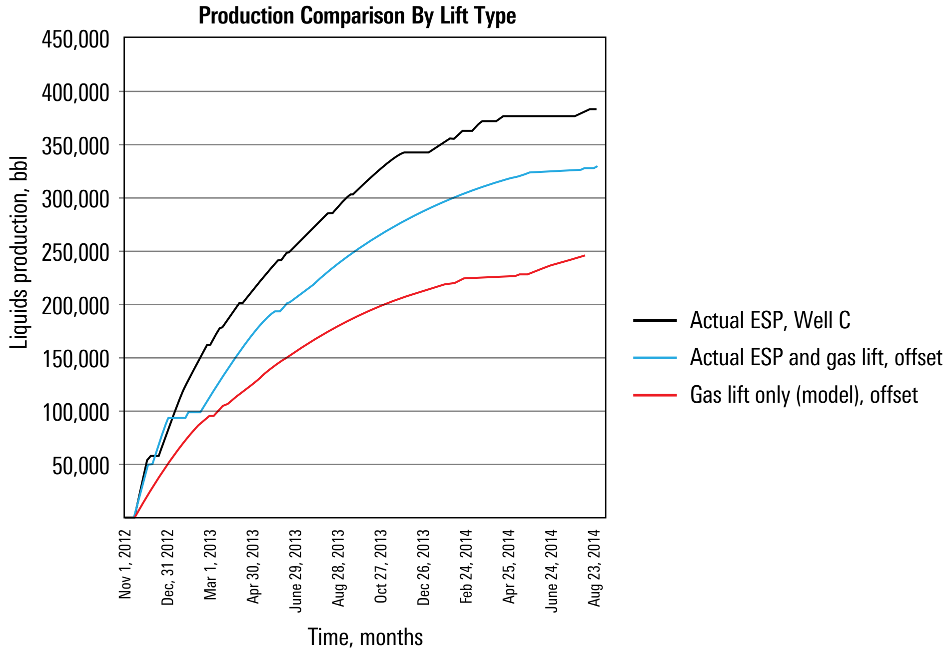
Gas, solids, and declining production challenge ESPs

Horizontal drilling and hydraulic fracturing technologies increased interest and initial production from the Mississippi Lime formation near the Oklahoma-Kansas border, but Chesapeake Energy found that rapid production declines, solids production, and high gas volume fraction challenged the performance of conventional ESP technology. Gas lift alone was an option to produce the wells, but Chesapeake wanted to use ESPs to accelerate production and cash flow. With their ESP run life averaging 118 days, Chesapeake needed a new solution to improve lifting costs.

The company asked Schlumberger for technology that could efficiently and flexibly handle oil production from initial levels near 4,000 bbl/d [636 m^3/d] down to 400 bbl/d [63.6 m^3/d] or less after a year of operation, and multiphase flow with increasing GLR from 300 to 1,700 cf/bbl [53 to 303 m^3/m^3]. The production was also expected to include solids from fracturing operations.

Robust pumps increase flexibility; monitoring optimizes performance

Schlumberger engineers began by redesigning the pumps to survive the expected conditions. Abrasion-resistant compression pumps were chosen to minimize risk of failure from sand production while functioning over a wide range of production volumes. Protectors with high-load thrust bearings were selected to carry the maximum downthrust from the pumps when operating at low rates. The pump configuration was also modified to add redundancy to sealing chambers. An MGH system and VGSA asemblies were installed to maximize flexibility for multiphase flow, especially during transient events. All systems were also designed to start operating at 50 Hz or less to minimize abrasion wear and accommodate the increasing GLR.



Robust ESPs and Lift IQ service accelerated production for Well C, producing 16% more cumulative liquid than a comparable offset produced with ESP and then converted to gas lift, and 55% more than gas lift alone.

To further optimize the pumps for well conditions, Phoenix xt150 system's downhole sensors were included for real-time monitoring of annulus pressure and temperature, motor temperature, vibration, current leakage, and pump discharge pressure, critical aspects for diagnosing pump problems and optimizing performance in unconventional wells. Finally, trend analyses from Lift IQ services were used in a continuous improvement process with detailed failure analysis.

ESP run life and cumulative production increase

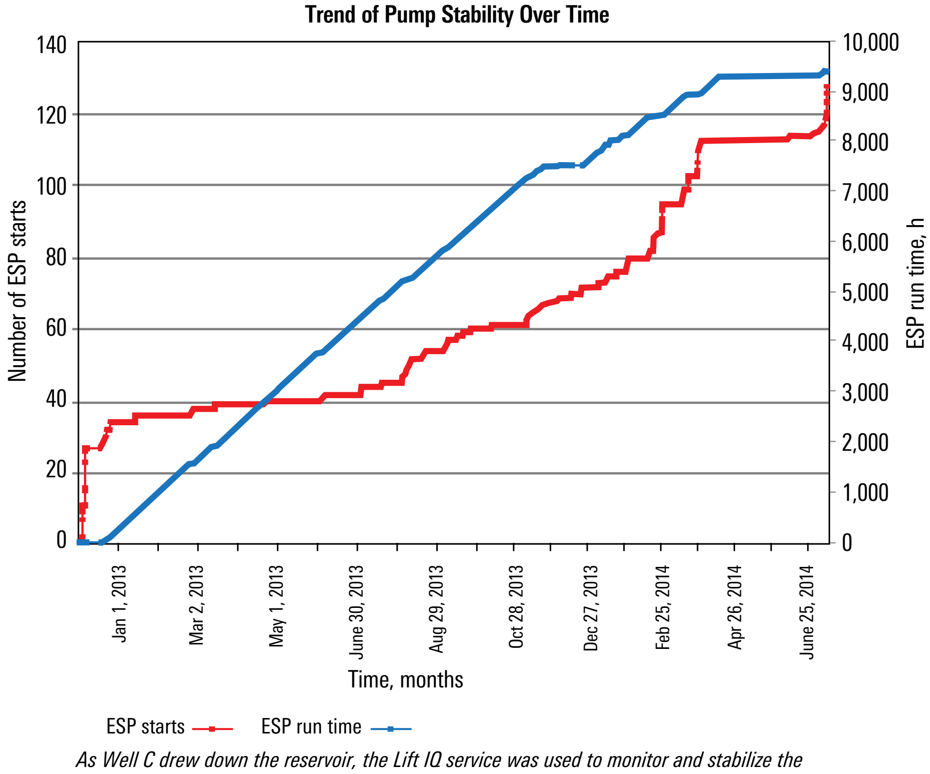
Upgraded ESPs were installed in seven wells. Three were pulled out of the wells prematurely when chunks of damaged plug and packer rubber clogged the intake or pump stages. Excluding those pumps, the average run life of the new ESP systems increased 2.81 times up to 332 days. Overall, the pumps managed as much as 94% production decline from more than 5,000 to 300 bbl/d [795 to 48 m^3/d] and up to 243% increases in GLR with even higher transient events.

In Well A, the ESP system and Lift IQ services managed a 94% production decline from 5,424 to 300 bbl/d [862 to 48 m^3/d] over 393 days with 86.4% uptime. The system also managed GLR increase from 350 to 1,200 cf/bbl [62.3 to 214 m^3/m^3], including days when GLR exceeded 2,000 cf/bbl [356 m^3/m^3]. In this well, the Lift IQ service was used to help overcome problems stemming from communication among wells; starting the ESP in a well tripped the ESP in an adjacent well.

In Well B, one ESP managed a 90% production decline and GLR increase from 320 to 1,300 cf/bbl [57 to 232 m^3/m^3] over 189 days. The ESP also managed drawdown, modifying pump intake from 1,000 to 600 psi [6.9 to 4.1 MPa]. A second ESP managed the lower production (200 bbl/d [32 m^3/d] of fluids and 250 Mcf/d gas [7.1 Mm^3/d]) for 262 days.

In Well C, the ESP system ran for 654 days through a steep fluid production decline from 4,275 to 750 bbl/d [680 to 119 m^3/d] in just 5 months, and a slower drop to 350 bbl/d [56 m^3/d] with GLR of 1,200 cf/bbl [214 m^3/m^3]. Cumulative uptime for the pump was 68.2%, with most of the downtime occurring for manual shutdowns, ESP trips for motor temperature during low- or no-flow events, and power-generation issues. This well also benefited from the Lift IQ service, which analyzed alarm incidents to optimize pump performance as downhole conditions changed, and to guide decision-making after communication from a nearby well. Well C also demonstrated the benefit of the ESP for accelerating production: At the end of its ESP lifetime, Well C had 16% more cumulative liquid production than a comparable offset produced with only 53 days on an ESP followed by gas lift, and 55% more cumulative liquid production than was modeled for gas lift alone.

In Well D, one ESP managed the production decline of 84% and GLR increase of 182%, drawing down the well from 1,300 to 400 psi [8.96 to 2.76 MPa] over 190 days. A second ESP accommodated the next 221 days of production, which declined steadily by 86%.



As Well C drew down the reservoir, the Lift IQ service was used to monitor and stabilize the pump with increasingly frequent adjustments. Based on the Lift IQ service analysis, Chesapeake temporarily shut in Well C because communication from another well destabilized it too much for reasonable adjustments.

slb.com/liftiq

Schlumberger