Reliability approach to cost-optimized ESP cable designs

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Context: Understanding the opportunity

- Higher reliability traditionally associated with higher product cost.

Customer Requirements

- Cost Effective
- Fit-for-purpose
- Reliable

- Lower oil prices provided a unique opportunity to create a cable design optimized for reliability and cost.

- Strategic approach on reliability during design and qualification process to offset traditional costs
Initiation: Establishing a reliability baseline

- Analysis of operating conditions was completed to determine necessary cable specifications for a fit-for-purpose cable design.

- Gap in operating conditions vs. cable specifications was identified to the current product (standard leaded ESP power cable). Use of over-specified designs yielded an opportunity for product tiering.

- A vast majority of all ESP failures related to electrical causes attributed to a “Power Cable” root cause were from splicing or damages suffered during installation, than well related factors. Therefore, an opportunity window in terms of a reliable fit-for-purpose design existed.
Development: Quantifying reliability targets

- Reliability block diagrams were created for existing designs (ELB) to quantify effects of components on overall reliability.

- Testing methodology was driven by the criticality of each component, with benchmarks to the established survivability of the existing design.

- As a result of the RBD, particular focus was given to:
  - Ensuring equal or greater performance of new electrical insulation materials.
  - Ensuring the integrity of the lead barrier over the entire lifetime of the cable.
Design: REDALead ELC-LPF  Key Characteristics

* - Design of ELC-LPF Construction and Materials are Patent Pending
Testing: Verification & Validation

Lab-scale reliability target verification
- Extensive electrical aging (insulation integrity)
- Extensive bending testing (lead barrier integrity)
- Thermal conditioning
- Fluid aging
- Simulated well conditioning

Field reliability target verification
- Extensive field trials
- 47 installations to date
- Longest running cable = 402 days (still in service)
Thank you!