Autonomous Digital Technology Supporting Corrosion and Scale Management

Christian Bonilla - Sep 2022
Shushufindi-Aguarico Field Block 57

- ≈ 50 years Production History
- 5.4 MM Bbls OOIP
- Operated by NOC EP Petroecuador
- Electrical Submersible Pumps (ESP)
Challenges

**160 ESPs**

**61,000 BOPD**

**245,000 BWPD**

**40 Platforms**

Wells have been over- or under-treated **50% of the time**

> **20%** failure rate due to corrosion and scale

**$8 M Annually**

**$5.3M Annually**
Chemical Treatment Program

Low level of effectiveness with initial production chemical programs

Ineffective production chemical management programs are cited as the root cause of 21% of ESP failures.

* Kimberlite International Oilfield Research.
Traditional Monitoring Process

Manual Data Sources
- Well Test/PDMS
- Injection Pump
- Chemical Tank

Manual Monitoring
- Target / Actual Injection Rate
- Inventory

Routine Analysis & Scale Prediction

Manual Computing

60 DAYS TIME LAPSED
Standardized Digitalization Approach

1. Understand
   Data needed at Higher frequency

2. Determine
   Which data could be obtained by existing systems / equipment

3. Identify
   Physics-based models to be used

4. Install
   Instrumentation to fill gaps

5. Implement
   Closed-loop control

6. Cloud
   Enable visualization and control
Optimized Monitoring Process

Connected Data Sources
- ESP
- Surf. P/T Sensors
- PDMS
- Injection Pump
- Tank Sensor
- Corrosion Probe

Edge Intelligence
- Agora
  - Virtual Flow Meter
  - Chemical Pump Control

Cloud Intelligence
- D E L F I Production Chemicals
  - Scale Prediction
  - Corrosion Prediction
  - Target Rate

Time Reduction
- 1 MIN TIME LAPSED
CSSFD

Automated Advisory System

Real-time corrosion and scale risk identification

Autonomous chemical injection

Automated generation of actionable insights
Production Real-Time Insights
Results After 20 Months

**Well1**
- **Installation:** AUG/2019
- **Chemical:** Scale Inhibitor
- **# Interventions:** 8
- **Last reason:** Broken coupling

**Well2**
- **Installation:** OCT/2020
- **Chemical:** Corrosion Inhibitor
- **# Interventions:** 9
- **Last reason:** Pipe detachment

---

### RESULTS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Average</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Reliability</td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>Response Time</td>
<td>99%</td>
<td></td>
</tr>
<tr>
<td>Injection Precision</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>CO2 Footprint Reduction</td>
<td>-75%</td>
<td></td>
</tr>
<tr>
<td>Corrosion/Scale Failures</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>
Results After 20 Months

- Autonomously adjusted injection 250–300 times per day
- ZERO failures to date
- 99% actual vs. target injection rate compliance
- > 75% reduction in field trips
- Virtual flow model has been within 3% of all well tests
- Estimated value: > $800K for 2 wells to date
Way Forward

1. SCALATION
   - Deployment solution on new wells CAPEX

2. STANDARDIZATION
   - Install solution in critical OPEX wells

3. SURFACE
   - Analyze solution for surface chemical treatment
Q/A

Thank you!