New Scale Detection Technologies For Geothermal Applications:

Advanced Virtual Pump Intake Pressure Machine Learning Models and GeoESP® Intake

Juan Pablo Atencia, Yuzhu Hu, Frank Corredor, Susana Tandazo, Casey Newport, Joshua Webster, Hans Sjerps, Xunlez Nuñez
## Agenda

**February 22\textsuperscript{nd}, 2024**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
</tr>
<tr>
<td>2</td>
<td>Methodology</td>
</tr>
<tr>
<td>3</td>
<td>Results</td>
</tr>
<tr>
<td>4</td>
<td>Conclusion</td>
</tr>
</tbody>
</table>
Introduction

Challenges

Geothermal ESP (GeoESP®):
Methodology

GeoESP® Digitalization

- 24/7 data science-driven platform
- Machine Learning
- Intelevate™
- Scale detection
  - Real-time diagnostics
  - Virtual Pump Intake Pressure
- Power optimization
  - Normalized KPIs
  - GeoESP® Intake
- Run life increase
  - Data-driven decisions
Results

Scale detection: **Virtual Pump Intake Pressure**

Machine Learning implementation

Real and Virtual parameters fully overlap with errors < 3%
Results

Scale detection: **Virtual Pump Intake Pressure**

Early detection
Results

Power consumption: GeoESP® Intake

- New inlet specifically designed for geothermal wells
- Prevents buildup of scale (DuraHard 3® coating)
- Perforated modular housing
- 5x increased flow area
- Reduced pressure drop by 30%
- Less power to operate (-10%)

![Graph showing intake pressure drop and flow rate](graph.png)
Results

Increase GeoESP® run life with real-time digitalization

01 Machine learning models
- PIP
- TDH
- Flow
- Electric

02 Events detection
- Downhole
- Surface

03 Real-time equipment status
- Pump
- GeoESP® Intake
- Motor

04 Increased system health
- Resonance
- Unbalance
- Operating range
Conclusion

Solution

Scale:
- Machine Learning

Power consumption:
- GeoESP® Intake

Run life:
- Intelevate™

12 applications and >1500 days of run life

24/7/365 continuous monitoring
Thank you

juanpablo.atencia@halliburton.com
intelevate@halliburton.com

+31 6 21230894
+1 918 947 4085
+57 310 352 1338

Halliburton, b.v.
Columbusstraat 19
7825 VP Emmen
The Netherlands