Actionable Information Saves $ 40 Million/Year

“PI AF transforms the way real-time data collected from thousands of similar assets can be analyzed so that only those assets that need attention NOW are brought to the attention of the right person. Instead of counting the cost of failure, each business unit counts the benefits of optimization.”

Business Challenge

- Potential cost of ESP failure extremely high
- 1,000’s of similar (but not identical) ESP’s
- How to decide which ESP is in danger of failing
- What to do to prevent ESP failure

Solution

- Implement PI System to capture relevant data
- Define common PI AF elements and data references
- Build PI ACE calculations to generate status reports
- Set up PI Notifications to report by exception

Results/Benefits

- Fewer days of lost production
- Reduction in mean time between failure, stop and gas lock rates
- Greater engineer/ and analyst work productivity

⇒ $ Millions
Industrial Evolution by the Numbers

• OSIsoft partner
• 3 business areas:
  Data-as-a-Service (hosted PI)
  PI Consulting & Project services
  Application development
• 2 main operation centers:
  Houston, TX
  Edmonton, AB
• 12 years of success
• 50+ expert staff
• 300+ customers
• 1,000+ partners
Proof of Concept (PoC) Project

US-Based Oil & Gas Major

1. Electric Submersible Pumps (ESP’s)
2. Business Opportunity
3. PoC Focus Areas
4. PoC Deliverables
5. Solution Architecture & PI System Components
6. PoC Results
7. Summary
Electric Submersible Pumps (ESP's)

ESP’s are placed at the bottom of oil and gas wells, operate in a extremely harsh environments, are hard to monitor, expensive to replace, and can lead to significant lost production if “problems” go undiagnosed or unnoticed.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Vertical Operating Depth</td>
<td>to 15,000 ft</td>
</tr>
<tr>
<td>Operating Volume</td>
<td>70 to 64,000 BFPD</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>to 500°F</td>
</tr>
<tr>
<td>Corrosion Handling</td>
<td>Good</td>
</tr>
<tr>
<td>Gas Handling</td>
<td>Good</td>
</tr>
<tr>
<td>Solid's Handling</td>
<td>Fair to Good</td>
</tr>
<tr>
<td>Fluid Gravity</td>
<td>&gt; 10° API</td>
</tr>
<tr>
<td>Service Requirements</td>
<td>Workover or Pulling Unit</td>
</tr>
<tr>
<td>Wellbore Deviation</td>
<td>0° to 90° Placement</td>
</tr>
<tr>
<td>Prime Mover</td>
<td>Electric Motor</td>
</tr>
<tr>
<td>Offshore Application</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
Business Opportunity

No. of ESP’s
- ~ 3800 installed ESPs

Gas Production
- ~ 6.6 MM BFPD
- ~ 250 M BOPD Gross

Failures
- Failure rate ~ 0.209
- ~ 800 failures/year

⇒ US$ 40 Million/Year in failure cost, exclusive of lost production
PoC Focus Areas

Primary Focus Area
Permian Basin, TX
San Joaquin Valley, CA

Secondary Focus Area
PoC Project Deliverables

“Capture, trending and exception reporting of ESP historic and real-time data”

1. **OSIsoft’s PI System will be implemented to capture, store and access ESP real-time data** including Current, Voltage, Power Frequency, Wellhead Pressure, Wellhead Temperature, Pump Discharge Pressure, Pump Intake Pressure and Motor Temperature at 5 minute intervals, as well as Actual Reservoir Performance Curves (Flow vs. Time), and Predicted Reservoir Performance Curves (Flow vs. Time).

2. **Data will be trended and compared with most recent polling values.** Instances where compared values exceed either an expected rate-of-change or pre-defined fixed limits will be recorded, registered graphically with email notification sent to the responsible/accountable party for remedial action.

3. **Asset Framework Database will be created** to include inventory details concerning ESP Product Design Performance Specifications such as, Model Numbers, Associated Parts and Maintenance Dates with Associated Maintenance Activities.
Solution Architecture

Daily Email/Incident Report

PI Notifications

PI ACE

PI Server

PI AF Server

PI to PI Interface

OPC to PI Interface

PI Server

OPC Server

CA (5)

Wells

TX (135)
PI AF Elements (1)
PI AF Elements (2)
PI AF Data References or DLLs

A series of user-configurable PI AF Data References were made available to monitor the following:

• Rate of Change
  ✓ Long term status of multiple well parameters
  ✓ Short term slope of parameters.

• Attribute Status
  ✓ Determines the status of a specific attribute.

• Equipment (Well) Status
  ✓ Determines the state of a well depending on the children Status attributes.
Reports

- PI ACE generates the status report (reporting times and content are user-configurable)
- PI Notifications creates summary reports (by exception)
Results: Gas Lock/Shutdown Prediction

**Early Observation**
A general increase in Motor Temperature (red) associated with a general decrease in Current Casing Gas Flowrate (white) typically led to an ESP gas lock and/or shutdown (X)

**Desired PoC Outcome**
Predict and warn of imminent ESP gas lock and/or shutdown before it happens
Next step was to determine the correlation between Motor Temperature and Current (Casing) Gas Flowrate as a predictor of imminent gas lock or motor stoppage.
Identification of Valid Business Rule

Identified Rule: when Current Gas Flowrate approaches 1000 MCF/Day place well on Watch List, and when Current Gas Flowrate approaches 750 MCF/Day place well on Warning List.
Results: Before vs After

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Mean Time Between ESP Locks/ Stops (Days):</td>
<td>7.75</td>
<td>10.5</td>
<td>35% improvement</td>
</tr>
<tr>
<td>Lost Production (Days):</td>
<td>16/31 (52%)</td>
<td>10/63 (19%)</td>
<td>63% improvement</td>
</tr>
<tr>
<td>Engineer/Analyst Work Productivity:</td>
<td>~ 90 sec/display</td>
<td>~ 10 sec/display</td>
<td>~ 250 - 400% improvement</td>
</tr>
</tbody>
</table>
Conclusion from PoC

Initial results from the ESP PoC indicate will see significant improvements in days of lost production, Mean Time Between Failure/Stop/Gas Lock Rates, and Engineer/Analyst work productivity by using broad based Reactive and Predictive Analytics.
Next Steps

Step 1
- Build Extra ESP Rules

Step 2
- Roll-Out to all ESP’s

Step 3
- Add More Asset Types
Take-Aways

• PI AF requires expert design considerations
• Decisions about how to design the asset hierarchy and where to perform calculations can make or break the project
• Once designed, repetitive application is extremely rapid
THANK YOU

Brought to you by OSIsoft

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