Daleel Production Surveillance via Real-Time Well Models

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Name: Muneer Al Balushi
Location: Oman

Beautiful, friendly, Safe
Daleel Petroleum

Role: RTO & Smart Fields Team Leader

“Local Oil and Gas exploration and production company”
“One of Leading Producers in Oman”
“50,000 BBL/D + Average”
Real-Time & Smart Fields (Agenda)

• Daleel Real-Time Operation Journey (Daleel Portal)
  Overview, Integration, Filtration, Analysis

• Daleel Dashboard (Key Features)
  • Daleel Real-Time Production
  • Well Surveillance
  • Exception Based Surveillance (EBS)
  • Beam Pumps Dyna Cards
  • Well Production Real-Time Surveillance (Model Based)
  • Virtual Metering
  • KPI’s

• Implementation Details

• Benefits / Conclusion
Daleel Petroleum (Overview)

- **Station A**
  - Separation
  - Oil Storage
  - Shipping

- **Station B**
  - Water Process
  - Separation
  - Water Injection

- **Gas Plant**
  - Lean Gas
  - LPG
  - NGL

- **Power Plant**
  - Gas Turbine
  - Generate Power

- **Manifolds**
- **Wells**

- **Export Meter**
  - Oil Export
Daleel Automation (Before)

Automation Systems
- Station A
- Gas Plant
- Station B
- Power Plant
- Wells
- Export Meter

2.5 Mil/D Real Time Data set
- Limited information
- Limited History
- Manual Entry
- Human Errors
- Transparency issues

Headquarter
- Analysis
- Development
- Decision Making

1k Data set / 5 hours
Daleel Real Time Operations (Plan)

Phase 1: Integration
Centralize real-time Data
(Data History & HQ accessibility)

2015

Phase 2: Filter & Alarm
Visualize Real-time + Static data
(Daleel Portal)

2016

Phase 3.1: Analyze
Exception Base Surveillance (EBS)
(Upgraded Daleel Portal)

2017

Phase 3.2: Analyze
Real-time Dyna Cards
Live Performance curve (wells/facility)
Live Well production (model based)

2018

Phase 3.3: Analyze
Surface Models
E-Well Book
Drilling integration

2019
Daleel Real Time Operations (Architecture) - 2015

- Connecting Real-Time Data with Static Data
- Centralized visualized tool

**PI DataLink**

**PI ProcessBook**

**Intelligence tool**

**DASHBOARDS PORTAL**

“SMART DALEEL PORTAL”

**PI System**

- Gas Plant SCADA
- Wells SCADA
- Station A DCS
- Station B DCS
- Power Plant DCS
- Export Meter

**AVOCET**
Daleel Dashboard (Stage 1) - 2016
Daleel Dashboard (Stage 2) - 2017
Daleel Dashboard (Stage 2) Key Features

• Field Real-Time Production
• Well Surveillance
• Exceptional Based Surveillance (EBS)
• Beam Pumps Dyna Cards
• Real Time Well Production (Based on a model)
• Virtual Metering
Field Real Time Production
Field Real Time Production

- Production Forecast
- Proactive Actions
Well Surveillance (Filter)
Well Surveillance

Types:
- Free Flowing
- Beam Pump (BP)
- Electrical Submerged pump (ESP)

REAL TIME

Aggregated
- Location
- Well Test
- Allocation
- Deferment
- Type
- Zone
- Lab Data
- Forecast

- Temperature
- Frequency
- Intake P
- Discharge P
- Fillage

Inflow

Outflow
Well Surveillance (template)
Well Surveillance

Well Info

Well Type: ESP
Field: Bushra
Block: Bushra NW
Reservoir: Natih
Completion Date: 24 May 2009
Avg. Estd. Liquid Rate: 855.99 bbl/d
Cum. Prod.: 16,506,177 bbl
Avg. THP: 2618.4 psi
Avg. Chp: 161.69 psi
Avg. Intake Press: 630.29 psi
Avg. PDP: 2037.43 psi

Producer

Injectors
Well “Test” / Well “Allocation”

**Liquid**
- Gross CD
- Oil CD
- Water Cut CD
- Gross
- Oil
- Water Cut

**Gas**
- Gas CD
- Gas
- GOR
Well Test History (Detailed)

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Test Status</th>
<th>Gross (Bbl/d)</th>
<th>Oil (Bbl/d)</th>
<th>Water (Bbl/d)</th>
<th>Gas (Mcf/d)</th>
<th>WC (%)</th>
<th>WHP (Psig)</th>
<th>GOR (scf/bbl)</th>
<th>Sep Pressure(Psig)</th>
<th>API (°API)</th>
<th>Choke (in.6)</th>
<th>Test Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Aug 2019</td>
<td>VALID</td>
<td>1043.07</td>
<td>281.67</td>
<td>751.4</td>
<td>159.93</td>
<td>73</td>
<td>232</td>
<td>1677.75</td>
<td>203.66</td>
<td>30.12</td>
<td>491.52</td>
<td>MPFM_007</td>
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<tr>
<td>24 Aug 2019</td>
<td>VALID</td>
<td>1043.62</td>
<td>283.71</td>
<td>759.91</td>
<td>162.11</td>
<td>72.81</td>
<td>212</td>
<td>571.10</td>
<td>204.59</td>
<td>30.12</td>
<td>491.52</td>
<td>MPFM_007</td>
</tr>
</tbody>
</table>

Deferment History (Tracking)

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Category</th>
<th>Deferment Group</th>
<th>Lost Oil Volume</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Aug 2019</td>
<td>ESP RELATED</td>
<td>UNSCHEDULED</td>
<td>23.07</td>
<td>Tipped due to underload.</td>
</tr>
<tr>
<td>09 Aug 2019</td>
<td>WELL OPTIMISATION</td>
<td>SCHEDULED</td>
<td>11.1</td>
<td>Stopped manually for choke replacement.</td>
</tr>
<tr>
<td>07 Aug 2019</td>
<td>ESP RELATED</td>
<td>UNSCHEDULED</td>
<td>24.05</td>
<td>Tipped due to underload.</td>
</tr>
<tr>
<td>20 Jul 2019</td>
<td>OTHERS</td>
<td>UNSCHEDULED</td>
<td>66.07</td>
<td>Total field tipped due to adverse weather condition (due to Sandstorm, Heavy Rain and lightning strike).</td>
</tr>
<tr>
<td>19 Jul 2019</td>
<td>OTHERS</td>
<td>UNSCHEDULED</td>
<td>24.05</td>
<td>Total field tipped due to adverse weather condition (due to heavy rain and lightning strike).</td>
</tr>
<tr>
<td>02 Jul 2019</td>
<td>ESP RELATED</td>
<td>UNSCHEDULED</td>
<td>235.65</td>
<td>Downhole Electrical failure. Generator service.</td>
</tr>
<tr>
<td>01 Jul 2019</td>
<td>ESP RELATED</td>
<td>UNSCHEDULED</td>
<td>236.66</td>
<td>Downhole Electrical failure.</td>
</tr>
<tr>
<td>30 Jun 2019</td>
<td>ESP RELATED</td>
<td>UNSCHEDULED</td>
<td>235.65</td>
<td>Downhole Electrical failure.</td>
</tr>
<tr>
<td>29 Jun 2019</td>
<td>ESP RELATED</td>
<td>UNSCHEDULED</td>
<td>235.66</td>
<td>Downhole Electrical failure.</td>
</tr>
</tbody>
</table>
Exception Based Surveillance (EBS) (Analysis)
Exception Based Surveillance (EBS)

EBS Component

- Expert Based Surveillance
- Expert Review & Follow-up
- Benchmarking & Performance Monitoring

High Level Workflow

- Generate
- Qualify
- Analyze
- Action
- Close

- Role 1
- Role 2
- Role 3

- Specialist Review

- Delegation Action
- False Alarm
- Acknowledge
- Closure

Exceptions Based Surveillance (EBS)
Exception Based Surveillance (EBS)

- Focused on Well Restoration
- Reduce Deferment
- Track actions taken
# EBS Events History (Well Level)

## Active Events

<table>
<thead>
<tr>
<th>Type</th>
<th>Start Time</th>
<th>Assigned To</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Intake Pressure High</td>
<td>22 Aug 2019 15:12:55</td>
<td>Sultan AlMahroqi</td>
<td></td>
</tr>
</tbody>
</table>

## Actions

<table>
<thead>
<tr>
<th>Type</th>
<th>Start Time</th>
<th>End Time</th>
<th>Status</th>
<th>Assigned To</th>
<th>Comments</th>
<th>Details</th>
</tr>
</thead>
</table>
Beam Pump Dyna Cards
Well Production Surveillance (Beam Pump)

Engineers take Pictures Manually

Beam Pump Panel
Well Production Surveillance (Beam Pump)
Well Production Surveillance (Beam Pump)

- Introduced a new philosophy using Controller Well State codes
Real-Time Well Production
(Based on Model)
(Well Virtual Metering)
Real-Time Data + Well Model

Model Manager

UPLOAD PROSPER MODEL

DOWNLOAD PROSPER MODEL

Model History

CreatedBy
Muneer Balashi

UpdatedTime
02 Jul 2019 8:43:02
Well Mismatch

New Well Test

ESP Pump Curve / Operating Point
Well Model Quick Calibration

### Well Test Info
- **Well**: BRI-006
- **Test Date**: 02 Sep 2019
- **Oil Rate**: 109.94 Bbl/day
- **Gas Rate**: 8.13 Mscf/day
- **Water Rate**: 510.38 Bbl/day
- **Liquid Rate**: 620.02 Bbl/day
- **GOR**: 73.95 scf/bbl
- **WC**: 82.28%
- **WHF**: 331 psig
- **Test Status**: VALID

### Model Info
- **Model Info**
  - **Original Model**
    - Calculated Liquid Rate (Bbl/day): 687.96
    - Liquid Rate rel. Error (%): 10.9
    - Reservoir Pressure (psig): 2000
    - Productivity Index (bbl/day/psi): 1.19
    - Watercut (%): 76
    - Gas-oil ratio (scf/STB): 400
    - Wear factor (1): 0

- **Altered Model**

### VLP/IPR

![Graph showing VLP/IPR relationship](chart)

- **VLP**
- **PDP**

**Buttons**
- **KEEP EXISTING MODEL**
- **ACCEPT ALTERED MODEL**

**Graph Details**
- **X-axis**: Gross Rate (Bbl/day)
- **Y-axis**: Pressure (psig)
Production Estimate based on matched Well Model

ESP/Free Flowing Wells: Based on Prosper Model

Beam Pump Wells: Theoretical Formula

\[ Q_{\text{liq}}(t) = \pi \left( \frac{\text{Pump Diameter}}{2} \right)^2 \cdot \text{Stroke Length} \cdot \text{Stroke Factor} \cdot \text{Fillage} \cdot SPM(t) \]
Virtual Metering
### Virtual Metering

![Virtual Metering Interface](image)

**Start Date:** 01/01/2019 21:00  
**End Date:** 04/05/2019 21:00

#### All areas

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMS</td>
<td></td>
<td></td>
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<tr>
<td>Shabba</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nalh</td>
<td>671,179.58</td>
<td>7,061.05</td>
<td>10,853.45</td>
<td>371,576.08</td>
</tr>
</tbody>
</table>

![Graph](image)

**Graph Details:**
- **X-axis:** Date
- **Y-axis:** Estimated liquid, oil, water, and gas rates
KPI’s

- Event Analysis
- Portal Usage
- Model Coverage
- EBS Tracking Compliance
Daleel Automation (Now)

**Automation Systems**
- Station A
- Gas Plant
- Station B
- Power Plant
- Wells
- Export Meter

**Daleel’s Real-Time Operational Infrastructure**

- Execution
- Maintenance

**Headquarter**
- Analysis
- Development
- Decision Making

- Production Forecasting
- Full History
- Automated Processes
- Exceptional Based Surveillance
- Production Virtual Metering
- Transparency
Implementation Details
Key Design Principles

1. Maximize the use of off-the-shelf products
2. Give control to users
3. Use PI AF as foundation
Implementation Details

• Architecture
• Visualization
• Exception Based Surveillance
• Model Integration
• Beam Pump Surveillance
Implementation Details

• Architecture
• Visualization
• Exception Based Surveillance
• Model Integration
• Beam Pump Surveillance
Architecture

Visualization Layer

Logic Layer

Data Service Layer

Data Sources
Architecture – OSIsoft stack

- Pi Vision
- Smart Portal
- Pi Analysis
- Custom Services
- Pi Web API
- AF SDK
- Asset Framework
- OpenServer
- Pi
- Relational DB
- Smart Portal DB
- Models

Visualization Layer
Logic Layer
Data Service Layer
Data Sources

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Architecture – Custom stack

Visualization Layer

Logic Layer

Data Service Layer

Data Sources
PI Asset Framework (AF) as a foundation

Already available in Daleel

Not just data service, but logic layer
Implementation Details

- Architecture
- Visualization
- Exception Based Surveillance
- Model Integration
- Beam Pump Surveillance
Visualization
Visualization - Structure
Visualization - Plots
Visualization – Process Schema
Implementation Details

• Architecture
• Visualization
• Exception Based Surveillance
• Model Integration
• Beam Pump Surveillance
Exception Based Surveillance (EBS)

• Reactive surveillance
• Large well count and remote operations
• Capture events in real time
• Precise assignments to engineers
Exception Based Surveillance (EBS)

Real-Time Data → PI Analyses → Event Manager → Smart Portal

Custom developed
Exception Based Surveillance (EBS)

• PI Analyses
  • Out-of-the-box functionality
  • Perfect for real-time processing
  • Empowers the users

• Event Manager
  • Highly configurable
  • Ensures follow-up
  • Builds knowledge base
Implementation Details

• Architecture
• Visualization
• Exception Based Surveillance
• Model Integration
• Beam Pump Surveillance
Model Integration

• Model Manager
  • Store models in the Smart Portal
  • Upload/download
  • Records history
  • Distribute

Smart Portal Server

Custom service

Petroleum Experts

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Model Integration

• Automated workflows
  • Connect real time data to models
  • Use existing API’s
  • Run automatically
  • Store results in PI
Implementation Details

- Architecture
- Visualization
- Exception Based Surveillance
- Model Integration
- Beam Pump Surveillance
Beam Pump Surveillance

• Streaming data from the controller to the Smart Portal
Benefits / Conclusions
Benefits

➢ Direct Impact
  ▪ Reduced the average monthly Beam Pump wells deferment by 2,000 BBL (1.4 Mil $)
  ▪ Improved Deferment booking by 1% (Allocation from 0.90 to 0.91)

➢ Expected Impact
  ▪ Increase the NFA (No Further Action) Wells Production by focused optimizations (Using EBS/Virtual metering/Dyna Cards)
  ▪ Increase Beam Pump wells production efficiency by 10% +
Conclusion

- OSIsoft provided the building blocks for Daleel “Real-Time infrastructure”
- Asset Framework (AF) can enable your Surveillance by Exception (EBS)
- PI Tools integration with well models can enable Virtual Metering
Presenters

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Questions?

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State your name & company

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