Integrated Live
Well & Surface Network
Model

Tool for Production Optimization
Fields Development (West Kuwait – UG) - Information Solutions - Exploration & Production Team

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SIS Global Forum
Monaco

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Umm-Gudair Field Introduction

- UG Field located in Kuwait
- Field Discovered in 1962
- Oil Formation: Carbonate
- 100% wells were producing with ESP’s
- Wells are flowing to two Gathering Centers
UG (MO) Reservoir Characteristics

- Carbonate reservoir with bottom water drive
- Upper layers with lower Permeability
- Good Communication between layers
- No faults, No fracture
UG (MO) Reservoir Characteristics

- Porosity 20 - 23%
- Permeability 50 – 500 md
- 450 ft Average Res, Thickness
- Reservoir pressure 1800 - 2800 psi
- Reservoir Temperature 175 F
Umm-Gudair Field Challenges

- Maintain Field production target.
- Minimize ESP failures and workovers.
- Address High water cut issues.
Objectives

Field Production Management
- Production Tracking
- Production Optimization
- Workovers

Well & Reservoir Performance
- Well Test
- Pressure Survey
- Pres. Gauges & Sensors

Optimum Filed Production
- 100% Surface & Sub-Surface efficiency
- Integrated Asset Modeling

Remove & Solve Restrictions & Bottle necking
Using **Integrated Asset Modeling** is the solution
Project Phases

Integrated Asset Modeling
Well Model (PHASE 1)

Well Production

| MPFM | Well Models |

Portable Test

Calibration

2%

Match Difference

Well Model
Workflow – Live Well Models

**Start**

- **OTS** (ESP Data)
- **ESP Data Available**
  - **Yes**: **Calculate**
    - FBHP, SBHP, PI, ESP Head, Downhole rate, Wear Factor
    - Update Well Model SBHP & PI
    - **Save Well Models**
  - **No**: **ECHO METER**
- **Well Test Data Available**
  - **Yes**: **CALCULATE**
    - FBHP, SBHP, PI
    - Update Well Model SBHP & PI
    - **Save Well Models**
  - **No**: **FINDER** (Well Test, WC%, SBHP)

**Calculate**

- FBHP, SBHP, ESP Head
- **Save Well Models**

**Estimate**

- Downhole rate, ESP Head, Wear factor
- **Save Well Models**

**End**

Daily Repeat The Process For All The Wells

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Filed Optimization & Calibration

Production decline, ESP trip
Echo meter survey done & PI calculated
Production Decline is due to Pump wear
Optimization Evaluation using well model
Frequency increased to 55 HZ
GC Surface Network Model (PHASE 2)

Optimum Production

100% Surface Facility Efficiency
Surface Network Model
Collaboration Surface Network Model TEAM

- Filed Development
- Information Solution Team (IS)
- Production Operation
- Information Managements (IM)

Surface Model
Potential 63,000 BOPD

LOSS 5,000 BOPD

Actual 58,000 BOPD

GC Headers

Separator

Heat Exchange

Water

Oil
Test Rate Potential Vs Actual GC Production

What is The Reason Of Difference

- Variation in Well Test (Portable Test) Rate.
- Total Liquid Rate Measurement Error In GC.
- GC Proceeding & Equipment efficiency
- Flow Line Network Bottle Necking Restriction & Back Pressure
Calibration

Diameter Calibration

6” -> 3”

Calibration
- Viscosity
- Elevation
- Diameter

Network = 160 psi
Actual = 250 psi

Separator 55 psi

UG-25
3500 bpd
P

UG-58
2200 bpd
P

P

UG-49
7900 bpd

5700 bpd
P
## Calibration

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Actual Flow Line Pressure $>\text{Optimum Flow Line Pressure}$

- Flow Line Integrity Issue
- Difference Between GC & Well Test
- Pipe Line Elevation
- High Viscosity

- Thermal Camera
- Flow Meter
- Sensitivity Runs
- PVT Test
- Ultrasound
- Red Eye
- Site Visit
- Lab Test
GC Surface Network Model

Well Parameters

Choke Size

Tubing Data

Reservoir Parameters

SBHP

PI

PVT

Fluid Parameters

Water Cut

GOR

Emulsion

Wear factor

Stages

Power

ESP Efficiency

Surface Operation Facilities

FLP

Sep. Pressure

Elevation

WKSN Automator
A. Screen The Under Performing Wells & Flowline

- Declining Rate and Productivity Index
- ESP’s On Up or Down thrust condition and with high wear
- To identify problematic Wells (integrity and flow assurance issues)
- To identify integrity and bottle necking in flow line.

B. To Evaluate Production Optimization Scenarios

- Choke and ESP Frequency (VSD) optimization.
- Evaluate of Stimulation impact and need for ESP replacement.
- To Divert well from GC to other GC

C. To Generate Daily Production Estimation Report
Filed Optimization – Well A

Well Integrity – Hole in Tubing:

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<th>Rate (BPD)</th>
<th>Water Cut (%)</th>
<th>ESP - PIP (Psi)</th>
<th>Tm (Deg F)</th>
<th>PI</th>
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<td>4500</td>
<td>80</td>
<td>1170</td>
<td>210</td>
<td>10</td>
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<tr>
<td>4100</td>
<td>75</td>
<td>1190</td>
<td>217</td>
<td>11</td>
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<td>4000</td>
<td>80</td>
<td>1200</td>
<td>218</td>
<td>11</td>
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<tr>
<td>3800</td>
<td>80</td>
<td>1350</td>
<td>218</td>
<td>10</td>
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<td>Work over</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4500</td>
<td>80</td>
<td>1200</td>
<td>220</td>
<td>10</td>
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Observation

Minor Hole in the tubing above pump and circulation of the fluid.

- There was a slight increase in motor Temp. around (4 Deg)
- Flow rate at the surface was Decrease around (800 bpd)

Well A
(Intake Pressure)
Filed Optimization – Well B

VSD Optimization:

<table>
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<tr>
<th>Rate (BPD)</th>
<th>Water Cut (%)</th>
<th>ESP - PIP (Psi)</th>
<th>Head Factor</th>
<th>PI</th>
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<td>950</td>
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<td>1900</td>
<td>5</td>
<td>N/A</td>
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<td>1850</td>
<td>10</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<td>1700</td>
<td>10</td>
<td>1100</td>
<td>0.65</td>
<td>2</td>
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<table>
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<th>Install VSD (Freq. 55 Hz)</th>
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<td>3100 15 900 0.65 4</td>
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<th>Frequency</th>
<th>Liquid</th>
<th>Oil</th>
<th>Water</th>
<th>Wcut</th>
<th>Net oil Gain</th>
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<td>55</td>
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Production decline
Echo meter survey done & PI calculated
Production Decline is due to ESP Efficiency
Optimization Evaluation using well model
Frequency increased to 55 Hz
Daily Estimation Report

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<th>#Wells</th>
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<td>66,193</td>
<td>71,926</td>
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<td>Cutback</td>
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<td>0</td>
<td>0</td>
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<td>Closed</td>
<td>12,272</td>
<td>2,094</td>
<td>10,178</td>
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<td>Failure</td>
<td>3,340</td>
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<td>Sub-Total</td>
<td>153,731</td>
<td>68,955</td>
<td>84,776</td>
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<th>Oil</th>
<th>Water</th>
<th>#Wells</th>
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<td>68,778</td>
<td>71,953</td>
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| Sub-total Open             | 138,664| 66,738| 71,926|        |
| Total                      | 154,276| 69,500| 84,776| 46     |
| Total OPEN                 | 138,664| 66,738| 71,926|        |

Daily Report:

- Groups the wells based on Reservoir / Status / GC wise.
- Potential for Cutback / Failure / Closed wells.
- Total Potential based on both well test and model estimated rates.
Daily Estimation Report

**Report Summary:**

- Pie chart shows the total oil and closed oil potential with WC% Distribution.
- Water shut ‘s off can be evaluated.

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Open Wells Summary:

- Flags if: well production variation is more than > 20%.
- Well need to be tested.
- Wells need for calibration and model updating.
## Daily Estimation Report

**Closed wells Summary:**

- Show reason of wells closed due to trips / Water cut / Maintenance.
- To Rank the closed wells for Rig Schedule OR Divert them to other GC.
Summary & Conclusions

Real time system was implemented in UG field (two GC’s) for 250 wells and system was up and running for 2 years.

• RT System & Automation provided a platform for auto updating the Surface network model.

• Created a continuous Well & ESP performance monitoring system and a daily report to track the overall field production.

• Model are useful to evaluate Production Optimization scenarios with constraints of declining pump efficiency and reservoir productivity etc.

• Overall System improved the average ESP run life and minimized the flowline bottle necking and restriction.
Thank You

*Kuwait Oil Company (KOC)*
Fields Development - West Kuwait – UG
Information Solutions - Exploration & Production Team

Questions..