Historical Gas Allocation and Reconciliation Study
South & East Kuwait

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Presentation Outline

01 Project Scope

02 Execution Steps

03 Results

04 Way Forward
Project Scope

RMC#59 entrusted E&P IM team to review gas allocation mismatch with measured data for South & East Kuwait.

Reconciliation of Measured Gas to the Wells and Reservoirs based on estimated well production.

Check for discrepancies between Measured gas volumes as reported by Gas Operation Team (P2S/IMLIVE) versus Reported (Finder) Volumes.

Deliver a Cleaned and Reliable Operational Dataset to be used for Reserves Calculations, Reservoir Simulation, Field Performance and Forecasting.

Develop workflow for robust Gas back allocation process.
Data Availability

The study was carried out for the period April 1988 up to Dec 2014.

The gas volumes from the two major databases before 2014 (P2ES & IMLive) were compared in the overlap period (Jan 2000 – Oct 2003) for QC, the results show a good consistency.

Data before 1988 was not available in terms of portable test, measured gas volumes (Production Operations) etc.

Checked all the available data:
- Data center
- Well history
- P2ES, IMLIVE, Finder & Avocet

A number of meetings were held between E&P IM assets, PO and RM team to understand the flow of data.
Review and Results of Back Allocation

Back Allocation Workflow

- Comparing the measured data to the allocated data
  - Establish a base line for allocation

- Operation Data
  - Check, fix and rerun

- Interpolation
  - Replace invalid test rates with closest valid ones within specified span of time

- Rate Estimation using Models
  - Locate GCs out of range (+/- 20%) and re-estimate the rates for invalid tests.
Total Gas Allocation Accuracy

Improvement of Gas Allocation Accuracy
Period 2000 - 2014

<table>
<thead>
<tr>
<th>Method</th>
<th>% of GGs within the Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>As is (Finder)</td>
<td>16%</td>
</tr>
<tr>
<td>Corrected (Operational Data)</td>
<td>71%</td>
</tr>
<tr>
<td>Corrected (Interpolation)</td>
<td>77%</td>
</tr>
<tr>
<td>Corrected (Well Model)</td>
<td>95%</td>
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</tbody>
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Improvement of Gas Allocation Accuracy
Period 1988 - 1999

<table>
<thead>
<tr>
<th>Method</th>
<th>% of GGs within the Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>As is (Finder)</td>
<td>7%</td>
</tr>
<tr>
<td>Corrected (Operational Data)</td>
<td>17%</td>
</tr>
<tr>
<td>Corrected (Interpolation)</td>
<td>51%</td>
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<tr>
<td>Corrected (Well Model)</td>
<td>60%</td>
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Study Results

Gas reconciliation Accuracy Improvement:

<table>
<thead>
<tr>
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<th>From</th>
<th>to</th>
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<tbody>
<tr>
<td>1988 – 1999</td>
<td>7%</td>
<td>60%</td>
</tr>
<tr>
<td>2000 - 2014</td>
<td>16%</td>
<td>95%</td>
</tr>
</tbody>
</table>

Results will improve decision making in:

01 Reserves Calculations

02 Improvement in the Back Allocation process

03 Simulation model for a better history match of the field production
Findings

Volumes is greater than reported for all reservoirs

01 Produced Gas

Period 1988 - 1999

23 % of the actual gas produced by SEK is not reported

02

Cost of uncertainty for unreported gas

03

Volumes as per natural gas price today ($2.72/MMBtu or Mcf) is roughly 1.5 billion USD.

04

New Workflow improved Allocation Process

Increased the number of GCs within acceptable range of reconciliation tolerance (+/- 20%) from 7 % to 60% for the period 1988 – 1999 and from 16% to 95% for period 2000 – 2014.
Way forward

Extend SEK study for the period prior to April 1988

After the successful implementation of the Project for the period 1988 -2014; the study was extended to the Period from 1946 to 1987 (since the start of the production).

After Finalizing the Study for S&EK; the project has been extended to West Kuwait and North Kuwait Fields

Study completed for KOC areas (SEK, NK, WK) on June 2019.
Thank you!!