Study the impact of improper choke design on gas production profile

Sep-2019
Nidoco Offshore gas filed discovered and operated by ENI Egypt,

- Gas Discovered at Jul-2015
- Production start up Aug-2015
- Reach Max plateau Nov-2017 (1150 MMSCF/D)
- Offshore field drilled from onshore location with deviation wells.
- Total Number of wells 14 wells
- Production process at Abu madi plant & EPF
- Maximum plants capacity ~ 1200 MMscf/D
Case study

Normal workflow
- Nidoco Offshore field drilled from onshore location with deviation wells up to ~ 4000 Mt depth
- The production profiles were generated initially using 3D model approach with generic constrains such as:
  - Plant capacity.
  - Arrival pressures.
  - Well deliverability and max draw down.
  - VLP of well completions.
  - Initial erosion rate as max production rate for each well

The issue;
- After drilling 10 wells the plateau declined early than expected,
- The main concerns of the decline “which is not implemented in normal workflow”;
  1. Choke size.
  2. Orifice restriction.

The challenges;
1. Capture the above mentioned issues and re-generate a forecast profile to capturing the effect of further constrains
2. Provide an optimization and improving actions to recover the production
Objective

- Study the impact of improper designed elements on the production forecast,

  1. **Surface elements (Orifice & Choke)?**
     - The production profiles forecast assumed that there is no pressure drop in the X-Tree valves.
     - The pressure drop across the any surface elements is a function of gas rate, so it can’t be consider a constant pressure drop.

  1. **Differentiate between the impact of each Surface element.**
     - For operational actions it is important to quantify the impact of each surface element individually.
### Updated Workflow

<table>
<thead>
<tr>
<th>Action</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Update the history match and generate production forecast using generic constrain with current wells rate as control</td>
<td>Eclipse</td>
</tr>
<tr>
<td>2- Model the impact of surface elements (orifice &amp; choke)</td>
<td>Pipesim</td>
</tr>
<tr>
<td>3- Include the impact of surface elements (choke &amp; orifice) in eclipse (Network option)</td>
<td>Eclipse/Network Model</td>
</tr>
<tr>
<td>4- Study the impact of the current choke size only by removing the orifice from the network.</td>
<td>Eclipse</td>
</tr>
</tbody>
</table>
History Match

--- Gas rate
--- THP
History Match

--- Gas rate

---- THP
History Match

- Gas rate
- THP

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Gas production rate [sm3/d] vs Date

Tubing head pressure [bar] vs Date
Forecast Profile using generic Constrains

1150 MMSCF/D plateau, Current gas rate of wells for production control

- Applying normal workflow the failed can sustain the plateau of 1150 MMSCFD for one year
The gas phase pressure drop is given by Bernoulli’s equation:

\[ \Delta P_G \propto \frac{1}{\rho_n} \left( \frac{Q_G}{A_{beam}} \right)^2 \]
Surface restrictions (Choke & Orifice)

Pressure drop match & pressure drop relations generations

<table>
<thead>
<tr>
<th>Well</th>
<th>Upstream Bars</th>
<th>Mid stream Bars</th>
<th>Downstream Bars</th>
<th>Gas rate MSmc/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>149.2</td>
<td>109.8</td>
<td>85.6</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>123.8</td>
<td>88.7</td>
<td>85.4</td>
<td>2.68</td>
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<tr>
<td>3</td>
<td>115.9</td>
<td>85.3</td>
<td></td>
<td>2.18</td>
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<tr>
<td>4</td>
<td>149.9</td>
<td>95.8</td>
<td>88.3</td>
<td>1.95</td>
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<tr>
<td>5</td>
<td>162.7</td>
<td>119.4</td>
<td>87.6</td>
<td>2.26</td>
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<td>137.4</td>
<td>127.6</td>
<td>87.8</td>
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<td>98.8</td>
<td>87.4</td>
<td>2.50</td>
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<td>8</td>
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<td>87.8</td>
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<td>3.56</td>
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<td>9</td>
<td>121.7</td>
<td>87.8</td>
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<tr>
<td>10</td>
<td>137.7</td>
<td>110.6</td>
<td>88.1</td>
<td>5.90</td>
</tr>
</tbody>
</table>

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Model the choke & orifice performance Using Nodal analysis;

- For each well generate the model of the choke and orifice.
- Match the pressure drop across each surface element per well.
- Generate VLP curve “Vertical lift performance“ for each surface element with expected range of gas rates and pressures

Pressure drop Across Choke & Orifice (Bars)

2.5 inch choke size performance

6 inch choke size performance
Surface restrictions (Choke & Orifice)
Implement the surface elements to 3D model

- Generate VLP curves for each element in the surface components
- Build network model as described below to integrate the VLP with the 3D model results
Impact of surface elements on Nidoco profile

- The surface elements have a significant impact on the production drop

Surface elements (Orifice & Choke)
Impact of surface elements (Choke & Orifice) well by well

--- Gas production rate

Minor impact because it has lower THP

- - - Surface elements (choke & orifice)  BC
Impact of surface elements (Choke & Orifice) well by well

Cont.

--- Gas production rate

- - - - Surface elements (choke & orifice)  --- BC
Surface restrictions (Choke only)
Implement the surface elements to 3D model

- Study the impact of **choke** if the orifice is removed.
  - Remove the orifice from the system
  - Build network model as described below

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**Main Manifold (88 bars)**

**North Manifold (85 bars)**

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**Well choke Node**

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**GRUPTREE**

- PLANT FIELD / M_MASTER PLANT /
- NX2_FL M_MASTER /
- NX2_OF NX2_FL /
- NX2_WH NX2_OF /
- NX2_FL M_MASTER /
- NX2_OF NX3_FL /
- NX2_WH NX3_OF /
- NX4_FL M_MASTER /
- NX4_OF NX4_FL /
- NX4_WH NX4_OF /
- NX6_FL M_MASTER /
- NX6_OF NX6_FL /
- NX6_WH NX6_OF /
- W2_FL M_MASTER /
- W2_OF W2_FL /
- W2_WH W2_OF /
- W2_FL M_MASTER /
- W2_OF W3_FL /
- W2_WH W3_OF /
- W4_FL M_MASTER /
- W4_OF W4_FL /
- W4_WH W4_OF /
- W5_FL M_MASTER /
- W5_OF W5_FL /
- W5_WH W5_OF /
- W6_FL M_MASTER /
- W6_OF W6_FL /
- W6_WH W6_OF /
- W8_FL M_MASTER /
- W8_OF W8_FL /
- W8_WH W8_OF /
- W9_FL M_MASTER /
- W9_OF W9_FL /
- W9_WH W9_OF /
- Ect...

**BRANPROP**

- PLANT FIELD 9999 /
- M_MASTER PLANT 9999 /
- NX2_FL M_MASTER 9999 /
- NX2_OF 23 /
- NX2_WH 9999 /
- NX3_FL M_MASTER 9999 /
- NX3_OF 25 /
- NX3_WH 9999 /
- NX4_FL M_MASTER 9999 /
- NX4_OF 27 /
- NX4_WH 9999 /
- NX6_FL M_MASTER 9999 /
- NX6_OF 10 /
- NX6_WH 9999 /
- W2_FL M_MASTER 9999 /
- W2_OF 32 /
- W2_WH 9999 /
- W3_FL M_MASTER 9999 /

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Impact of current choke opening only on Field profile
Impact of current choke position only

Remove the orifice from the system

Well 6
- The current choke position has a significant impact.
- If the choke is fully open so it is recommended to be upgraded.

Well 9
- The current choke position has a significant impact.
- If the choke is fully open so it is recommended to be upgraded.
Impact of current choke position only
Remove the orifice from the system

Well 3
- The current choke opening has a significant impact.
- If the choke is fully open so it is recommended to be upgraded.

Well 10
- The current choke has a significant impact in future (1Q of 2018)

Choke actions
1. Wells 3, 6, 9, and 10 current choke position will affect on the production profile and need to be upgraded and revised
Conclusion

- All orifice elements have a significant impact on Field profile.
- 4 wells (3, 6, 9, and 10 current choke position will affect the production profile and need to be upgraded and revised)

1- BC (no bottleneck)
2- Surface elements constrain
3- Choke only constrain