From: "Baker, Kate H (Swift)" <Kate.Baker@bp.com>
Sent: Friday, July 02, 2010 7:34:34 PM
To: <srtiesz@sandia.gov>; <pnelson@usgs.gov>; <pahsieh@usgs.gov>; <mooney@usgs.gov>; "Catherine B Enomoto/GD/USGS/DOD" <cenomoto@usgs.gov>; <srtiesz@sandia.gov>; <hickman@usgs.gov>; "Mark A. Havstad" <havstad@1lanl.gov>; "Morrow, Charles W" <cmorro@sandia.gov>; "Dykhuizen, Ronald C" <cdykhui@sandia.gov>; "Ammerman, Curtt N. (ANL)" <ammerman@lanl.gov>
CC: "Wells, Kent" <kent.wells@se1.bp.com>
Subject: Science Call Follow-Up

Attachments: Attachment

We had an action from the Macondo Shut-In & Well Test Protocol Meeting to ensure that the National Labs and USGS scientists had a file note on depletion, and this came up again on the Science call. Here is the file note on depletion.

<<Macondo Technical Note - Depleted Pressures vC.ZIP>> .
Macondo Technical Note - Depleted Pressures vC.ZIP
Macondo Technical Note

Title: Depleted Pressure
Contributors:
Issued by:
Date: July 1, 2010
Version: C – DRAFT

Question Addressed in this Technical Note:
Discussions with the National Laboratories and other teams has resulted in a request for an estimated reservoir pressures for the Macondo field. This note provides the reservoir pressures calculated for the case in which the reservoir has produced at constant 35,000 stb/d from 20-April to 1-July.

Key Conclusions

Well Block Pressures at shut-in on 1-July-2010
Deposition Simulated from 4/21/2010 (cumulative prod.: 2.52 mmstb total production)

<table>
<thead>
<tr>
<th>Reservoir Section</th>
<th>Top Depth ft TVDSS</th>
<th>Near Well Pressure psia</th>
<th>Reservoir Pressure psia</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>M110</td>
<td>8.969</td>
<td>4.730</td>
<td>4.730</td>
<td>gas sand at 18” shoe (depth of 18” shoe)</td>
</tr>
<tr>
<td>M57B</td>
<td>17.361</td>
<td>10.876</td>
<td>11.567</td>
<td>gas sand (cross flow)</td>
</tr>
<tr>
<td>M57C</td>
<td>17.614</td>
<td>11.297</td>
<td>12.875</td>
<td>gas sand (cross flow)</td>
</tr>
<tr>
<td>M56A</td>
<td>17.718</td>
<td>10.248</td>
<td>9.895</td>
<td>gas sand (cross flow)</td>
</tr>
<tr>
<td>M56C</td>
<td>17.890</td>
<td>10.846</td>
<td>10.878</td>
<td>water sand (little flow)</td>
</tr>
<tr>
<td>M56C</td>
<td>17.944</td>
<td>11.059</td>
<td>11.771</td>
<td>water sand (little flow)</td>
</tr>
<tr>
<td>M56C</td>
<td>17.981</td>
<td>10.921</td>
<td>11.529</td>
<td>oil sand</td>
</tr>
<tr>
<td>M56E</td>
<td>18.034</td>
<td>10.942</td>
<td>11.258</td>
<td>Main Oil Sand (on which 11,850 psi is based)</td>
</tr>
<tr>
<td>M56F</td>
<td>18.132</td>
<td>10.939</td>
<td>11.524</td>
<td>oil sand</td>
</tr>
</tbody>
</table>

Note: all pressures hydrocarbon pore volume weighted at mid-point of reservoir layer

These calculations were repeated with crossflow between the deep sands and the M110. For the purposes of this exercise the M110 sands were made effectively “infinite” (using a pore volume multiplier) to minimize the impact of increasing reservoir pressure:
Well Block Pressures at shut-in on 1-July-2010 (With Crossflow to M110 Sand)
Depletion 35mbd from 4/20/2010 (cumulative prod: 2.5E mmstb total production)

<table>
<thead>
<tr>
<th>Reservoir Section</th>
<th>Top Depth (ftVDSS)</th>
<th>Near Well Pressure psia</th>
<th>Reservoir Pressure psia</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>M110</td>
<td>8.969</td>
<td>5,503</td>
<td>4,731</td>
<td>gas sand at 18&quot; shoe (depth of 18&quot; shoe)</td>
</tr>
<tr>
<td>M57B</td>
<td>17.361</td>
<td>9,863</td>
<td>10,866</td>
<td>gas sand (cross flow)</td>
</tr>
<tr>
<td>M57C</td>
<td>17.614</td>
<td>10,750</td>
<td>11,282</td>
<td>gas sand (cross flow)</td>
</tr>
<tr>
<td>M56A</td>
<td>17.718</td>
<td>9,067</td>
<td>8,744</td>
<td>gas sand (cross flow)</td>
</tr>
<tr>
<td>M56B</td>
<td>17.890</td>
<td>9,955</td>
<td>9,957</td>
<td>water sand (little flow)</td>
</tr>
<tr>
<td>M56C</td>
<td>17.944</td>
<td>10,349</td>
<td>10,454</td>
<td>water sand (little flow)</td>
</tr>
<tr>
<td>M56D</td>
<td>17.961</td>
<td>9,996</td>
<td>11,229</td>
<td>oil sand</td>
</tr>
<tr>
<td>M56E</td>
<td>18.034</td>
<td>9,800</td>
<td>10,644</td>
<td>Main Oil Sand (on which 11,850 psia is based)</td>
</tr>
<tr>
<td>M56F</td>
<td>18.152</td>
<td>9,991</td>
<td>11,164</td>
<td>oil sand</td>
</tr>
</tbody>
</table>

Note: all pressures hydrocarbon pore volume weighted at mid-point of reservoir layer
M110 Sand modeled as effectively "infinite", hydrocarbon PV = 0.6x10^12 reservoir bbls

All pressures are reported 0.1 days (2.4 hours) after shut-in.

Assumptions

1. The calculation was performed using a VIP simulation model with the following parameters:
   - Oil B_o: 2.345 rh/stb
   - c_r: 6 x 10^-6 psia^-1
   - c_w: 3 x 10^-6 psia^-1
   - GOR: 2993 SCF/stb
   - OIP: 109.9 mmstb
   - Reservoir Volumes: Oil: 257.8 mmrb, S_w: 9.7% (in M56E, varies in other zones), Aquifer: 991.6 mmrb (excludes connate water, 3.8x oil volume)

2. The model is a stylized representation of the reservoir, with each layer homogeneous, and no dip.
   - The “near well pressure” is taken from the well’s gridblock, with dimensions of 100 x 100 ft.
   - The model includes the M57(B, C) and M56(B, C, D, E, F) sands, and was originally created to address whether the wellbore could become gas filled during shut-in at the “topkill.”
   - The M57 gas sands have a higher initial pressure than the main oil sands; they are modeled with a limited areal extent. These sands contribute some flow for the first 10 days of production, during which time the predicted GOR drops from 4,600 SCF/stb to 3030 SCF/stb.
   - For depletion with only the M56D-F open, depletion at a constant 35 mbd would yield a near well pressure in the M56E of 10,889 psia, and there would be no change in the sand’s average pressure.
3. Reservoir sands' properties and depths were modelled per spreadsheet “MC252 – 1 Sand Description v2.xls”, (24-May, email Kelly McAughan, attached). The sands without permeability but calculated porosity were assigned a nominal permeability (see table).

4. The “skins” on all reservoir intervals were set to 0, in order to maximise the impact of crossflow. The largest crossflow rates (at the sandface in reservoir barrels/day) were:

- No shallow crossflow:  
  M56A: -7,000 rb/d
  M56E: 4,000 rb/d

- Shallow crossflow:  
  M110: -49,000 rb/d
  M56E: 41,000 rb/d
## Reservoir Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 1</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Layer 2</td>
<td>0.05</td>
<td>0.06</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>Layer 3</td>
<td>0.09</td>
<td>0.10</td>
<td>0.11</td>
<td>0.12</td>
</tr>
</tbody>
</table>

**Draft for Discussion**

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If Density lag is not corrected to match core porosity

1. From core in MBD 1 and MMMB, Kinkhabwala air core and net core for Archie, etc., use 3999 psi is a function of core porosity. Net core for Archie, etc., use 3999 psi is a function of core porosity.

2. Log porosity is calculated to core porosity and net core for Archie, etc., use 3999 psi is a function of core porosity.

3. Log porosity is calculated to core porosity and net core for Archie, etc., use 3999 psi is a function of core porosity.

Gross has VSI out of Val-8-4

Net has a Porosity out of Paranal 14

Pay has a SMI out of Val-8-4

Water Depth = -992 feet

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P 4 of 4

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