Step-Rate Test, Interference Test Results and DST Results in Wellington

• Step-rate test was modeled with FEKETE
  - Permeability and skin were calculated
• Interference test was modeled with FEKETE
  - Composite model was considered for this test due to change in permeability and flow capacity at some distance from the wellbore.
  - Two permeabilities were calculated for two radii (regions) from 1-32.
Step-Rate Test Results in 1-32 Gauge Depth at 4,869 ft Test Interval: 4,995–5,020

Calculated permeability from step-rate test is 113 mD for 30 ft interval that has vertical communication based on Lorenz plot. There are vertical barriers above and below this interval. 25 ft of this interval is perforated. This permeability is close to log derived average permeability (74mD) for the same interval.
Interference Test Results in 1-32 and Choosing 1-28 as an Observation Well

Well 1-32 was the injection well and 1-28 was the observation well. Distance between 1-32 and 1-28 is 3,500 ft. Better results were obtained when Composite model with Dual porosity-permeability was considered. Based on this model, permeability around well 1-32 to a radius of 2,493 ft (region 1) has a lower value (100 mD) for 30 ft interval that is in vertical communication. Permeability is 124 D from radius of 2,493 ft to the vicinity of 1-28. Permeability derived from the Interference test is close to log derived average permeability (74mD). Bigger permeability for the farther radius can be associated with fracture or fault between two wells.
Composite Model Diagram and Parameters

This model shows the two zones with different radii and permeabilities. Zone 1 is from well 1-32 to a radius of 2,493 ft and zone 2 is from 2,493 ft to well 1-28.
DSTs Validity in 1-32

• DST 1 and 4 are only suitable for analysis
• DST 2 and 3 are not suitable for analysis:
  -DST 2: Flowing pressure is equal to shut-in pressure; therefore, there is no build-up to analyze. Just temperature and pressure are useful.
  -DST 3: DST Flowing pressure is equal to shut-in pressure; therefore, there is no build-up to analyze.
DST 4 in 1-32

Interval: 4,175–4,190 ft
DSTs Validity in 1-28

• Only DST 1 is suitable for analysis.
• DSTs 2, 3 and 4 are not suitable for analysis:
  - DST 2: Flow period is short and doesn’t have transient period. Pressure from this test is useful.
  - DST 3: Like DST 2, has a short transient time. Pressure from this test is useful.
  - DST 4: Not suitable for the same reasons as 2 and 3.
DST 1 in 1-28
Interval: 5,133–5,250 ft
# Results

## Well 1-32

<table>
<thead>
<tr>
<th>DST Interval</th>
<th>K from DST</th>
<th>Log connectivity</th>
<th>Average Log derived K90</th>
<th>Average Core K90</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft</td>
<td>mD</td>
<td>ft</td>
<td>mD</td>
<td>mD</td>
</tr>
<tr>
<td>4175-4190</td>
<td>2.32</td>
<td>4175-4090</td>
<td>4.61</td>
<td>4.59</td>
</tr>
</tbody>
</table>

## Well 1-28

<table>
<thead>
<tr>
<th>DST Interval</th>
<th>K from DST</th>
<th>Log connectivity</th>
<th>Average Log derived K90</th>
<th>Average Core K90</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft</td>
<td>mD</td>
<td>ft</td>
<td>mD</td>
<td>mD</td>
</tr>
<tr>
<td>5133-5250</td>
<td>2.60 mD</td>
<td>5133-5160</td>
<td>2.17 (5133-5160)</td>
<td>NA</td>
</tr>
</tbody>
</table>

## Step-Rate Test results

<table>
<thead>
<tr>
<th>Interval</th>
<th>Gauge depth@</th>
<th>K from Step-rate test</th>
<th>Average log derived K90</th>
<th>Average Core K90</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft</td>
<td>ft</td>
<td>mD</td>
<td>mD</td>
<td>mD</td>
</tr>
<tr>
<td>30</td>
<td>4869</td>
<td>113</td>
<td>74</td>
<td>NA</td>
</tr>
</tbody>
</table>

## Interference test result

<table>
<thead>
<tr>
<th>Interval</th>
<th>K for zone 1</th>
<th>K for zone 2</th>
<th>Ave K90 from log for zone1</th>
<th>Average Core K90</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft</td>
<td>mD</td>
<td>D</td>
<td>mD</td>
<td>mD</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
<td>124</td>
<td>74</td>
<td>NA</td>
</tr>
</tbody>
</table>
• Permeability calculated from step-rate test and interference test are almost in agreement with log-derived permeability.
• Permeability calculated from DST tests in 1-32 and 1-28 is in agreement with core data.
• Permeability of 124D from the interference test is associated with a radius farther away from 1-32 to the vicinity of well 1-28, which can be related to fault or fracture.
• Appropriate model and correct thickness were not selected in the former analysis. Skin was large and, therefore, calculated permeability was affected by the large skin.
• Results can be improved if correct model and thickness selected.
Comments Regarding the Previous Step-Rate Test Analysis

• Thickness of injection zone was assumed 200 feet, which is not right. Perforated interval is 25 feet and it is in the middle of FU 14 according to Lorenz plot. Thickness of this unit is only about 30 ft, and it is bounded by almost impermeable layers, which are above and below the unit.

• Calculated skin factor (s) is 200. This high s is very abnormal in carbonate reservoirs.

• Since the skin is very high, to obtain pressure match, calculated permeability times thickness (kh) had been increased to 4.24E+5, which is not correct.
Comments Regarding the Previous Interference Test Analysis

• Thickness of injection interval was assumed 200 ft, which is not correct. Actual thickness of affected interval by injection is 30 ft or less as was discussed.

• Volume of reservoir affected by injection had been increased by a factor of 6.66. Therefore, pressure signal at well 28 is reduced by a factor of 6.66. To compensate for this reduction, higher permeability had been calculated.