Two Rate Well Test

However, with wells producing fluids, there may be a lack of knowledge regarding the presence of fluids in the well bore after shut-in. If fluids are present after shut-in, the surface pressure may not be accurately converted to bottom-hole pressure and use of the SPI DR® gauge would be precluded.

When doubts exist as to the presence of a fluid column after shut-in, SPI DR® gauge users have elected to use a 2-rate flowing test which eliminates concerns about fluid accumulation in the well bore. The 2-rate test allows the user to calculate skin and permeability in the same manner as with a build-up test, the only difference being that the 2-rate test will yield average reservoir pressure (p-bar) as opposed to p*, reservoir pressure at infinite shut-in time.

Conducting a 2-Rate Test

The standard build-up test is a 2-rate test in which one of the flow rates is zero! Before shut-in for a build-up test, the operator will flow his well at constant rate for a period long enough to ensure there are no pressure transients in the reservoir. The same is true for the 2-rate test but instead of shutting in the well, the rate is simply increased or decreased an amount sufficient to change the flowing wellhead pressure by at least 10%. It is very important that the new flow remain as constant as possible. Care must also be taken, if the rate is decreased, that the reduced flow rate will continuously unload all produced fluids. Click here to calculate the minimum flow required to continuously unload fluids without slugging. The flowing well-head pressure for a given tubing size is used to determine the minimum flow rate.

The graph below shows a pressure versus time plot for a 2-rate test in which the flow rate was reduced. Note that the reservoir pressure is declining at some stabilized value before the flow rate change. In this example, after a flow rate decrease, the WHP increases immediately and then begins a stabilized rate of decline less steep than before the flow rate reduction.

![Well-head pressure vs. time for 2-rate test.](image)

Benefits of the 2-Rate Test

Operators using the 2-rate test have determined that it not only yields comparable results to build-up tests but also has several benefits. The 2-rate test avoids the following problems with build-up tests:

1. Loss of cash flow during a build-up.
2. Fluid accumulation during a build-up may require assistance to unload when the well is re-opened.

3. After a build-up, some wells have difficulty returning to pre-test flow rates.

Analysis of the 2-Rate Test

Since the build-up test is a 2-rate test in which one of the flow rates is zero, the analysis of data in both cases is almost identical. As can be seen in the following equation, when the second flow is zero, the equation for pressure response reduces to the familiar build-up test equation:

\[
p_{w1} = p_i - \frac{162.6 q_2 \mu B}{kh} \left[ \log \frac{k}{\phi \mu c_r^w} - 3.23 + .87s \right]
- \frac{162.6 q_1 \mu B}{kh} \left[ \log \frac{t + \Delta t'}{\Delta t'} + \frac{q_2}{q_1} \log \Delta t' \right]
\]

Detailed descriptions of analysis of the 2-rate test are available from the following references:


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