# Objectives of Well Testing

## A. Determine a well's productivity

A well's productivity is a measure of the well's ability to produce fluids under an imposed pressure drop.

$$J = \frac{q_o(t)}{\left(\bar{p}(t) - p_{wf}(t)\right)}$$

where at a given time,

J = productivity index, stbd/psi

P = average reservoir pressure in a well's drainage region, psi

$P_{wf}$ = bottomhole flowing pressure, psi

q = production rate, stbd

Productivity Index is a function of transmissibility, storativity, well geometry, reservoir geometry, respectively.

$$J = \frac{kh}{141.2\mu_o B_o[\ln(r_e / r_w) - 0.75]}$$

1. *Permeability (k)* -Permeability can be obtained from either core data or welltest analysis. Be aware that core data is **not** on the same scale as production; and therefore could be invalid. Welltest data investigates a larger reservoir volume and thus is more appropriate.
2. *Thickness (h)* - The best source of determining the producing zone thickness is through well logs. This thickness represents the reservoir thickness and not the perforated interval.
3. *Wellbore radius ($r_w$)* - This is the size of the drilled hole and can obtained by caliper logs or if not available, the bit size with which the hole was drilled
4. *Radius of drainage ($r_e$)* - The radius of drainage is rarely known and therefore is typically estimated. If available a reservoir limit test will provide the drainage volume; otherwise a typical estimate is to use the statutory well spacing as an approximation. Fortunately, due to the nature of natural logarithms an exact value of $r_e$ is not critical. A reasonable approximation is to assume: $\ln\frac{r_e}{r_w} - 0.75 \approx 7.08$

5. *Fluid properties ($\mu_o B_o$)* - both properties can be determined by either PVT fluid data or by general correlations. Both are functions of pressure; however, for undersaturated oils the composite effect of the product is small. Table 1 illustrates the linear variation of $\dfrac{1}{\mu_o \mathrm{B_o}}$ for pressures above bubblepoint. If desire to account for pressure dependency then must include terms in the integrand.

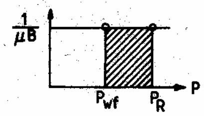
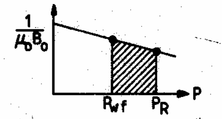
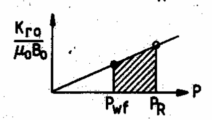
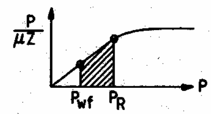
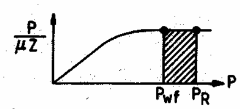
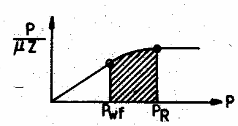
| Case | Integral form of Darcy's Equation | Pressure function | Integral of the pressure function |
|---|---|---|---|
| Ideal liquid | $q_o = \dfrac{2\pi kh}{\ln r_e/r_w - 0.75 + s + Dq} \displaystyle\int_{p_{wf}}^{p_R} \frac{1}{\mu B}\,dp$ |   | $\dfrac{p_R - p_{wf}}{\mu B}$ |
| Undersaturated oil | $q_o = \dfrac{2\pi kh}{\ln r_e/r_w - 0.75 + s + Dq} \displaystyle\int_{p_{wf}}^{p_R} \frac{1}{\mu_o B_o}\,dp$ |   | $\dfrac{p_R - p_{wf}}{(\mu_o B_o)_{av}}$ |
| Saturated oil | $q_o = \dfrac{2\pi kh}{\ln r_e/r_w - 0.75 + s + Dq} \displaystyle\int_{p_{wf}}^{p_R} \frac{k_{ro}}{\mu_o B_o}\,dp$ |   | $\dfrac{p_R^2 - p_{wf}^2}{2p_R}\left(\dfrac{k_{ro}}{\mu_o B_o}\right)_{p_R}$ |
| Low-pressure gas | $q_g = \dfrac{2\pi kh}{\ln r_e/r_w - 0.75 + s + Dq} \dfrac{T_{sc}}{p_{sc}T_R} \displaystyle\int_{p_{wf}}^{p_R} \frac{p}{\mu Z}\,dp$ |   | $\dfrac{p_R^2 - p_{wf}^2}{2\mu Z}$ |
| High-pressure gas | $q_g = \dfrac{2\pi kh}{\ln r_e/r_w - 0.75 + s + Dq} \dfrac{T_{sc}}{p_{sc}T_R} \displaystyle\int_{p_{wf}}^{p_R} \frac{p}{\mu Z}\,dp$ |   | $\dfrac{p(p_R - p_{wf})}{\mu Z}$ |
| Entire gas pressure range | $q_g = \dfrac{2\pi kh}{\ln r_e/r_w - 0.75 + s + Dq} \dfrac{T_{sc}}{p_{sc}T_R} \displaystyle\int_{p_{wf}}^{p_R} \frac{p}{\mu Z}\,dp$ |   | $m(p_R) - m(p_{wf})$ |

Table 1. Pressure function assumptions (from Golan and Whitson,1991)

***The primary objective of well test analysis is to determine the productivity index ( or combination of parameters) and average reservoir pressure.***

Determine if:

1. rate is limited by the reservoir's capacity to transmit fluids….kh/μ
2. rate is limited by lack of reservoir energy…average reservoir pressure
3. rate is limited by the well's completion…skin

## B. Identify Reservoir characteristics

- homogeneous vs heterogeneous
- layered, natural fractured, faults
- isotropic or anisotropic

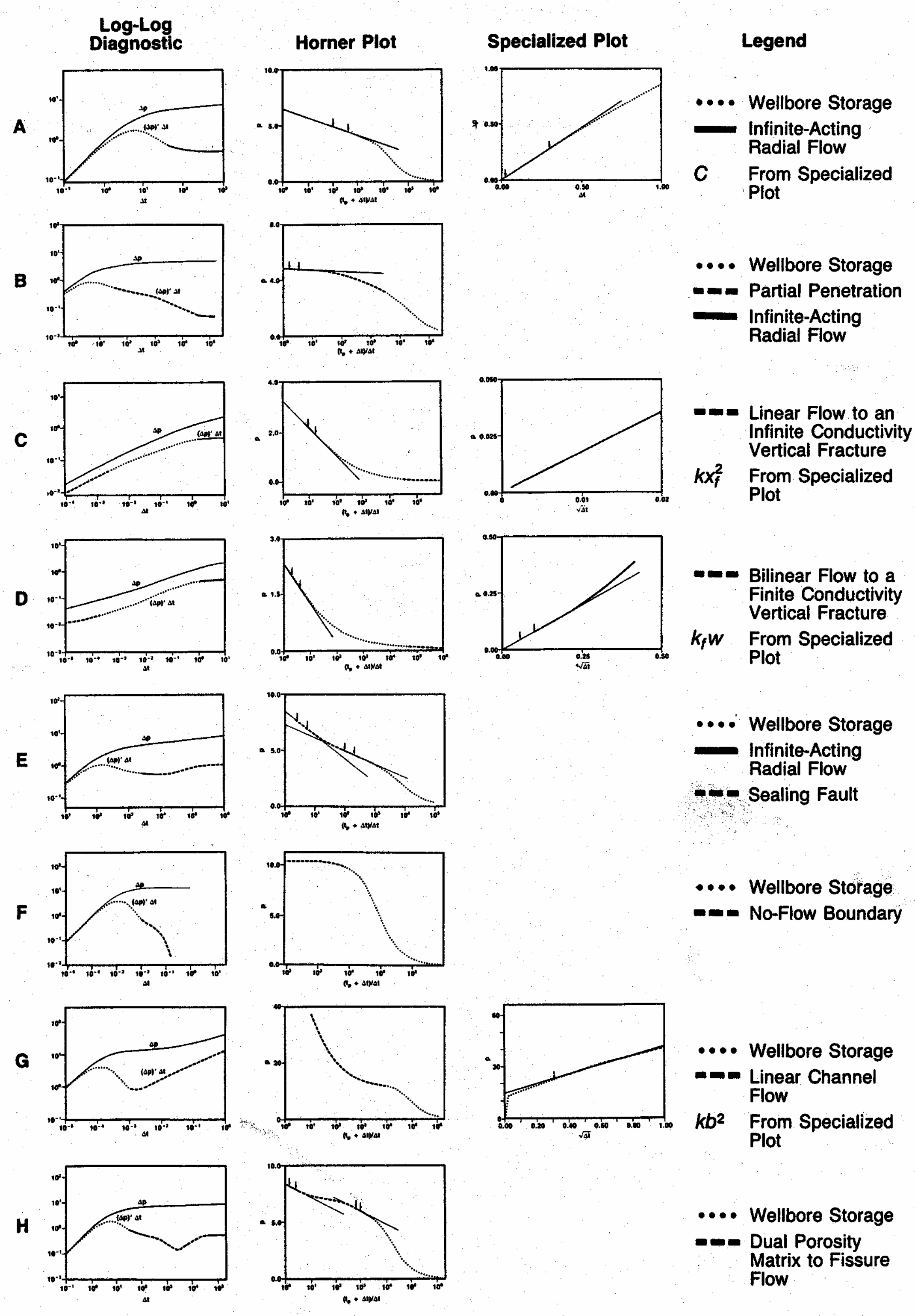



Figure 2. Pressure, pressure derivative and specialized plots for common reservoir features. (From Economides and Nolte, 1989)

## Advantages of well testing

1. insitu test
2. flow-based test and analysis
3. large investigative volume