These attached data were taken from a pressure buildup test performed on an oil reservoir — the reservoir is assumed to be homogeneous.

Reservoir properties:
\[ \phi = 0.30 \quad r_e = 0.28 \text{ ft} \quad c_i = 3.67 \times 10^{-5} \text{ psia}^{-1} \quad h = 59 \text{ ft} \]

Oil properties:
\[ B = 1.625 \text{ RB/STB} \quad \mu = 0.39 \text{ cp} \]

Production parameters:
\[ q_o = 1000 \text{ STB/D} \quad t_f = 1000 \text{ hours} \]

Required: Pressure Buildup Analysis — you are to estimate the following parameters:

Part a — Early Time Analysis

Preliminary Log-log Analysis: (Use the \( \Delta p' \) data on the log-log plot)

Wellbore storage coefficient, \( C_s \) = __________ RB/psi

Formation permeability, \( k \) = __________ md

Cartesian Analysis: (Early Time Data)

Pressure at the instant of shut-in, \( p_w(\Delta t = 0) \) = __________ psia

Wellbore storage coefficient, \( C_s \) = __________ RB/psi

Part b — Middle Time Analysis (Permeability and Skin Factor)

Semilog \((\Delta t)\) Analysis: \((IARF = \text{Infinite-Acting Radial Flow})\)

Formation permeability, \( k \) = __________ md

Skin factor, \( s \) = __________ dimensionless

Semilog (Horner) Analysis: \((IARF = \text{Infinite-Acting Radial Flow})\)

Formation permeability, \( k \) = __________ md

Skin factor, \( s \) = __________ dimensionless
Part a — Early Time Analysis

Preliminary Log-log Analysis: (Use the $\Delta p'$ data on the log-log plot)
Wellbore storage coefficient, $C_s$ = RB/psi
Formation permeability, $k$ = md

(You MUST show all work and clearly identify/label ALL features)

![Log-Log Plot](image)

**Work Space:**

**Wellbore Storage Coefficient, $C_s$:**

$$C_s = \frac{qB}{24m_{wbs}}$$

**Permeability, $k$:**

$$k = 70.6 \frac{qB\mu}{h} \frac{1}{\Delta p'_{LARF}}$$

($m_q$ is calculated from the log-log plot $m_q = \ln(10) \times \Delta p'_{eff}$)
Part a — Early Time Analysis

**Cartesian Analysis:** (Early Time Data)

Pressure at the instant of shut-in, $p_{wf}(\Delta t=0) = $ ______ psia
Wellbore storage coefficient, $C_s = $ ______ psia

*(You MUST show all work and clearly identify/label ALL features)*

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**Work Space:**

*Wellbore Storage Coefficient, $C_s$:*

$$C_s = \frac{qB}{24m_{wbs}}$$

$m_{wbs}$ is forced from the log-log plot.

*Pressure at the instant of shut-in, $p_{wf}(\Delta t=0)$*

$$p_{wf}(\Delta t = 0) = 1360 \text{ psia}$$
Part b — Middle Time Analysis (Permeability and Skin Factor)

Semilog (Δt Analysis; LARF = Infinite-Acting Radial Flow)

Formation permeability, \( k \)

Skin factor, \( s \)

(You MUST show all work and clearly identify/label ALL features)

![Semilog Summary Plot (Radial Flow — No Rate History)](image)

Work Space:

Note: \( m_{sl} \) is forced from the log-log plot.

Permeability, \( k \):

\[
k = 162.6 \frac{qB_{u}}{m_{sl}h}
\]

Skin Factor, \( s \):

\[
s = 1.1513 \left[ \frac{p_{ws,1hr} - p_{wfg}(\Delta t = 0)}{m_{sl}} - \log \left( \frac{k}{\phi \mu c r_w^2} \right) + 3.2275 \right]
\]
Part b — Middle Time Analysis (Permeability and Skin Factor)

Semilog (Horner) Analysis: (IARP = Infinite-Acting Radial Flow)

Formation permeability, $k =$ m.d
Skin factor, $s =$ dimensionless

(You MUST show all work and clearly identify/label ALL features)

Work Space:

Note: $m_d$ is forced from the log-log plot.

Permeability, $k$:

$$ k = 162.6 \frac{q_BT}{m_d h} $$

Skin Factor, $s$:

$$ s = 1.1513 \left[ \frac{p_{wri} - p_{rft}}{m_d} \right] - \log \left[ \frac{t_p}{t_p + 1} \right] - \log \left[ \frac{k}{\phi \mu c r_w^2} \right] + 3.2275 $$
a. Typical flow regimes encountered during production (liquid system).

b. Typical "flow-after-flow" or 4-point test, (assumes pseudosteady-state flow for each rate).

c. "Deliverability" or "Backpressure" plot used to estimate maximum well productivity.
a. $q_g$ and $p_{wf}$ vs. $t$: East Texas Gas Well 1.

b. $\Delta p_{p}/q_g$ vs. $G_p$: East Texas Gas Well 1.

c. $q_g$ and $p_{wf}$ vs. $t$: East Texas Gas Well 2.

d. $\Delta p_{p}/q_g$ vs. $G_p$: East Texas Gas Well 2.

e. $q_g$ and $p_{wf}$ vs. $t$: Barnett Field Well SR1.

f. $\Delta p_{p}/q_g$ vs. $G_p$: Barnett Field Well SR1.
$q_{g,pow}(t) = \alpha t^{-\beta}$

$\beta =$ Slope $= 0.5$
$\alpha =$ Intercept $= 24,000$ MSCFD

Intercept $= 24,000$ MSCFD
$q_{g,pow}(t=1 \text{day})$

Slope $= 1:2$
\[ q_{g, \text{exp}}(t) = q_{i, \text{exp}} \exp[-D_{\text{exp}}(-t)] \]

\[ q_{g, \text{hyp}}(t) = \frac{q_{i, \text{hyp}}}{(1 + bD_t)^{1/b}} \]

\[ \beta = \text{Slope} = 0.5 \]

\[ \alpha = \text{Intercept} = 24,000 \text{ MSCFD} \]

\[ D_{\text{exp}} = \left| \frac{\ln(3,550 \text{ MSCFD}) - \ln(460 \text{ MSCFD})}{(0 \text{ d}) - (450 \text{ d})} \right| = 0.0045 \text{ 1/d} \]

Intercept = 3,550 MSCFD
(at time zero)
(0 d, 3,550 MSCFD)

(450 d, 460 MSCFD)
\[ q_{g, \text{exp}}(t) = q_{g,i} - D_i G_p \]

\[ q_{g, \text{hyp}}(t) = q_{g,i} \left[ 1 - \frac{G_p}{\frac{q_{g,i}}{(1-b)D_i}} \right] \]

Cartesian Plot of Gas Rate versus Cumulative Gas Production
SPE 084287 Pratikno et al

Intercept = 3,550 MSCFD
(at cumulative production = zero)

\[ D_{\text{exp}} = \frac{(3,550 \text{ MSCFD} - 0 \text{ MSCFD})}{(900,000 \text{ MSCF} - 0 \text{ MSCF})} \]

\[ = 0.004 \text{ 1/d} \]

(900,000 MSCF, 0 MSCFD)