Key

PETE 324

Exam B

March 10, 2004

50 minutes, closed book except for 2 cheat sheets, calculator, and straight edge.

Turn in you cheat sheets with your exam.

Show your work. Include the units. Use symbols instead of values when necessary.

1. (20 points) A well has the following data:

p_i = 4,141 psia	μ = 3.1 cp	h = 185 ft
q = 123 stb/d	ϕ= 0.16	r_w = 0.24 ft
B_o = 1.12 rb/stb	$c_t = 12 \times 10^{-6}$ psi^{-1}	S_w = 0.22

Suppose the well has been producing at a constant rate for 420 days. The well has a productivity index of 0.34 stb/d/psi and a drainage area of A = 1.15 x 10^6 ft^2.

(a) Calculate the pore volume and original oil-in-place (OOIP).

(b) Calculate the average reservoir pressure at 270 days (use the tank model approach).

(c) Calculate p_{wf} at 270 days assuming that the well is in pseudo-steady state.

a) Pore Volume, PV

$$PV = A h \phi = 1.15 \times 10^6 ft^2 * 185 ft * 0.16 * (1/5.615 \ ft^3/rb) = 6.06 \times 10^6 rb$$

$$OOIP = \frac{6.06 \times 10^6 rb * (1-0.22)}{1.12 \ rb/stb} = 4,221,982 \ stb$$

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b) Average Pressure @ t = 270 d

$$\frac{\Delta P}{\Delta t} = -\frac{qB}{V_p C_t} \qquad \Delta P = \frac{(123 \ stb/d)(1.12 \ rb/stb) * 270 d}{(6.06 \times 10^6 rb)(12 \times 10^{-6} psi^{-1})} = 511 \ psia$$

$$\bar{P} = (4141 - 511) psia = 3630 \ psia$$

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c) Pwf at 270 d

$$J = q / (\bar{P} - P_{wf}) \qquad P_{wf} = \bar{P} - q/J$$

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$$P_{wf} = 3630 \ psia - \frac{123 \ stb/d}{0.34 \ stb/d/psi} \qquad P_{wf} = 3270 \ psia$$

2. (20 points) Suppose you *did not know the productivity index* in problem 1, but can use all the other data. Use the Dietz shape factor tables. You estimate that the well is in the center of a 2 x 1 rectangle and that k = 7.1 md.

(a) Calculate the productivity index (stb/d/psi).

(b) When is the end of the SLSL?

(c) When does pseudo-steady state begin?

Shape Factor = 21.8369

a) Productivity Index

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$$J = \frac{0.00708\, kh}{B\mu\left[\frac{1}{2}\ln\left(\frac{10.06\,A}{C_A r_w^2}\right) - 3/4\right]} = \frac{0.00708\,(7.1\,md)(185\,ft)}{(1.12\,rb/stb)(3.1\,cp)\left[\frac{1}{2}\ln\left(\frac{10.06 \times 1.15\times10^6\,ft}{21.8369 \times (0.24\,ft)^2}\right) - \frac{3}{4}\right]} = 0.368\ stb/d/psi$$

b) End of SLSL (Exact $t_{DA} = 0.025$)

$$t = \frac{\phi \mu c_t A\, t_{DA}}{0.000264\, k} = \frac{(0.16)(3.1\,cp)(12\times10^{-6}\,psi^{-1})(1.15\times10^6\,ft^2)(0.025)}{0.000264 \times 7.1\,md} = 91.3\ hr$$

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c) PSS begin ($t_{DA} = 0.3$)

$$t = \frac{(0.16)(3.1)(12\times10^{-6})(1.15\times10^6)(0.3)}{0.000264 \times 7.1} = 1095\ hr$$

-7

3. (20 points) Suppose wells A and B are in an *infinite homogeneous reservoir* a distance of 680 ft apart. Well B has a skin factor of 8.5 and begins producing at 150 stb/d at t = 0. Well A has a skin factor of 3.9 and begins producing 400 hours later at 110 stb/d.

(a) Calculate the effect of well B on well A at t = 1,600 hours.

(b) Calculate the effect of well A on well A at t = 1,600 hours.

(c) Caculate the total effect of A and B to give p_{wf} in well A at t = 1,600 hours. **[Use necessary data from Problem no. 1 and use k = 5.5 md.**

a)
$$t_{Dr} = \frac{0.000264\, k\, t}{\phi \mu c_t L^2} = \frac{0.000264(5.5\,md)(1600\,hr)}{0.16 \times (3.1\,cp)(12\times10^{-6}\,psi^{-1})(680\,ft)^2} = 0.844$$

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From Fig. C-2 $P_D = 0.46$

$$\Delta P_{B-A} = \frac{141.2\, P_D\, q_B\, B\mu}{kh} = \frac{141.2(0.46)(150\,stb/d)(1.12\,rb/stb)(3.1\,cp)}{(5.5\,md)(185\,ft)} = 33.2\ psi$$

b)
$$t_{Dr} = \frac{0.000264(5.5)(1200)}{(0.16)(3.1)(12\times10^{-6})(0.24)^2} = 5082325$$

⇒ From fig. C-2 $P_D = 7.8$

$P_{D(+skin)} = 11.7$

$$\Delta P_{A-A} = \frac{141.2\,(11.7)(110)(1.12)(3.1)}{(5.5)(185)} = 620\ psi$$

-7

c)
$$\Delta P_{TOTAL} = \Delta P_{A-A} + \Delta P_{B-A} = (620 + 33.2)\,psi = 653.2\ psi$$

$$P_{wf} = P_i - \Delta P_{TOTAL} = (4141 - 653.2)\,psi = 3488\ psia$$

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4. (20 points) We have a well producing for a closed square reservoir. We want to evaluate the well, so we produce it at constant rate of 123 stb/d for 1,000 hours and then shut it in. Below is the shut-in time and pressure data. **Use necessary data from Problem no. 1.**

Shut-in time, hours	Shut-in pressure, psia	$(t_p+\Delta t)/\Delta t$
3	3571	334.33
6	3630	167.66
15	3718	67.66
43	3803	24.25

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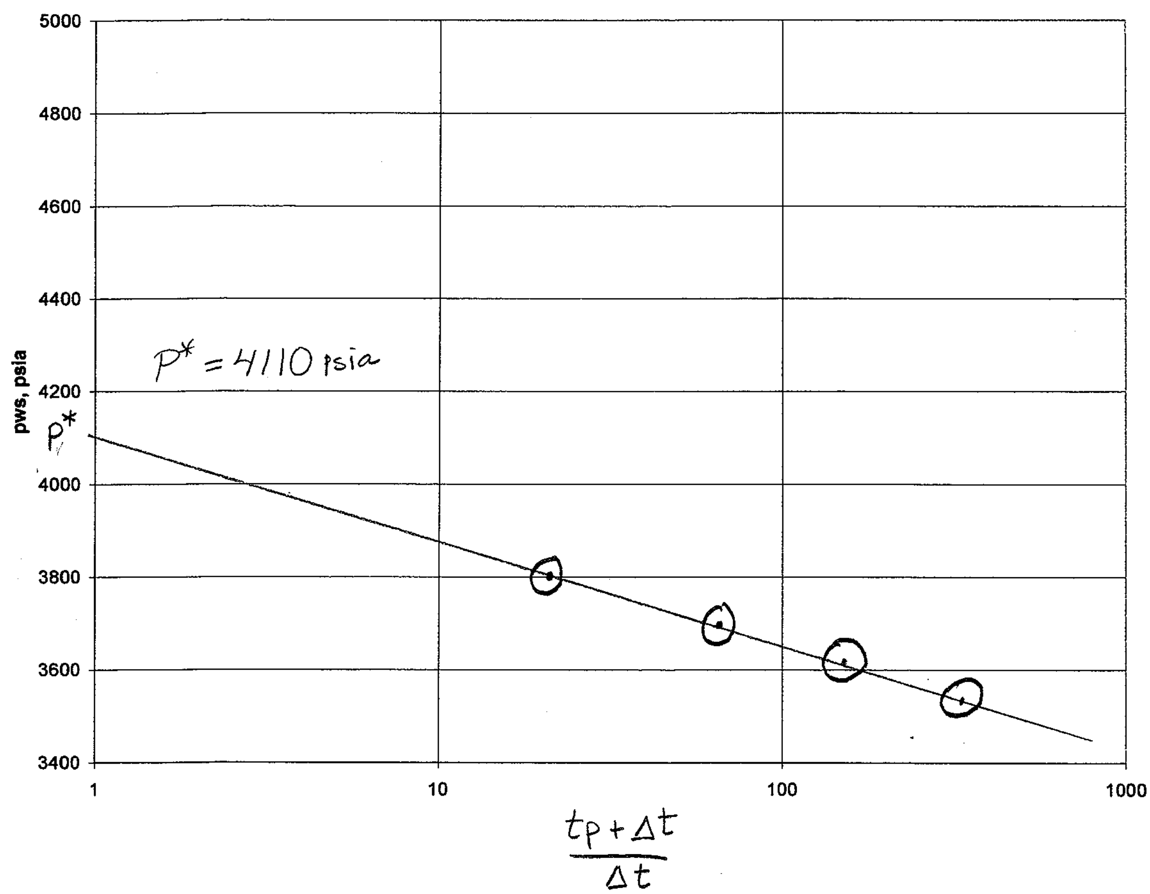
Analyze this as a build-up test.
(a) Calculate the plotting variables,
(b) Make a Horner plot
(c) Determine the permeability
(d) Determine the average reservoir pressure



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(c)

1) Slope, m

$$m = \frac{(3803-3571)\text{ psia}}{\log(24.25/334.33)} = -205 \text{ psia/cycle}$$

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2) $$K = 162.6\frac{qB\mu}{mh} = 162.6\frac{(123\text{ stb/d})(1.12\text{ rb/stb})(3.1\text{ cp})}{(205\text{ psia/cycle})(185\text{ ft})} = 1.83\text{ md}$$

(d)

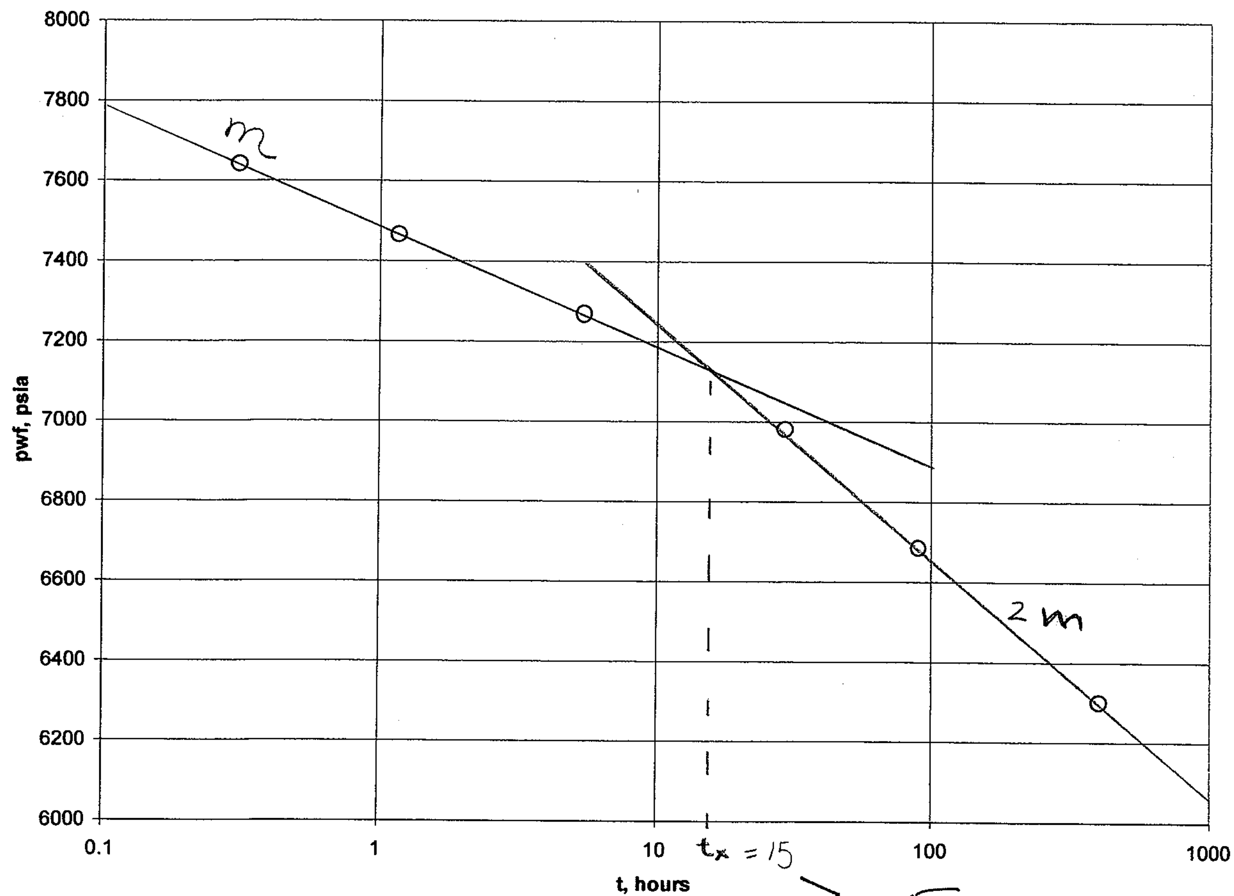
3) $$t_{P_{DA}} = \frac{0.000264\,K\,t_P}{\phi\,\mu\,C_t\,A} = \frac{0.000264(1.83\text{ md})(1000\text{ hr})}{(0.16)(3.1\text{cp})3(12\times10^{-6}\text{ psia}^{-1})(1.15\times10^{6}\text{ ft}^2)} = 0.07$$ -5

4) From Plot $P_{DMBH} = 0.85 \Rightarrow \bar{P} = p^* - \frac{m}{2.303} * P_{DMBH} = 4110 - \frac{205}{2.303} * 0.85 = 4035$ psi

5. (20 points) We expect that a well is fairly close to a fault, so we perform a drawdown test on the well (see below). **[Use necessary data from problem no. 1].**

(a) Calculate k.

(b) Calculate the distance to the fault.



1) SLSL Slope, m

$$m = \frac{(7180-7780)\text{psia}}{2 \text{ cycle}} = -300 \text{ psia/cycle}$$ -5

2) Permeability, K -5

$$K = 162.6 \frac{q\mu B}{m h} = 162.6 \frac{(123 \text{ stb/d})(3.1 \text{ cp})(1.12 \text{ rb/stb})}{(300 \text{ psia/cycle})(185 \text{ ft})} = 1.25 \text{ md}$$

3) Distance to Fault, L -5

$$L = \sqrt{\frac{0.000148\, K\, t_x}{\phi \mu\, C_t}} = \sqrt{\frac{0.000148 * 1.25 \text{md} * 15 \text{hr}}{0.16 * 3.1 \text{ cp} * 12\times10^{-6} \text{psia}^{-1}}} = 21.59 \text{ ft}$$