PETE 324
Homework no. 6
March 31,2003

SOLUTION

(Due Wednesday, April 7)

You will find the file Gringarten fracture type curve.xls on our directory. This contains the digitized data to plot the Gringarten curves for constant rate production from an infinite conductivity fracture in a closed square. There are two graphs in this xls file. Each graph uses a different "characteristic length" in the dimensionless time definition.

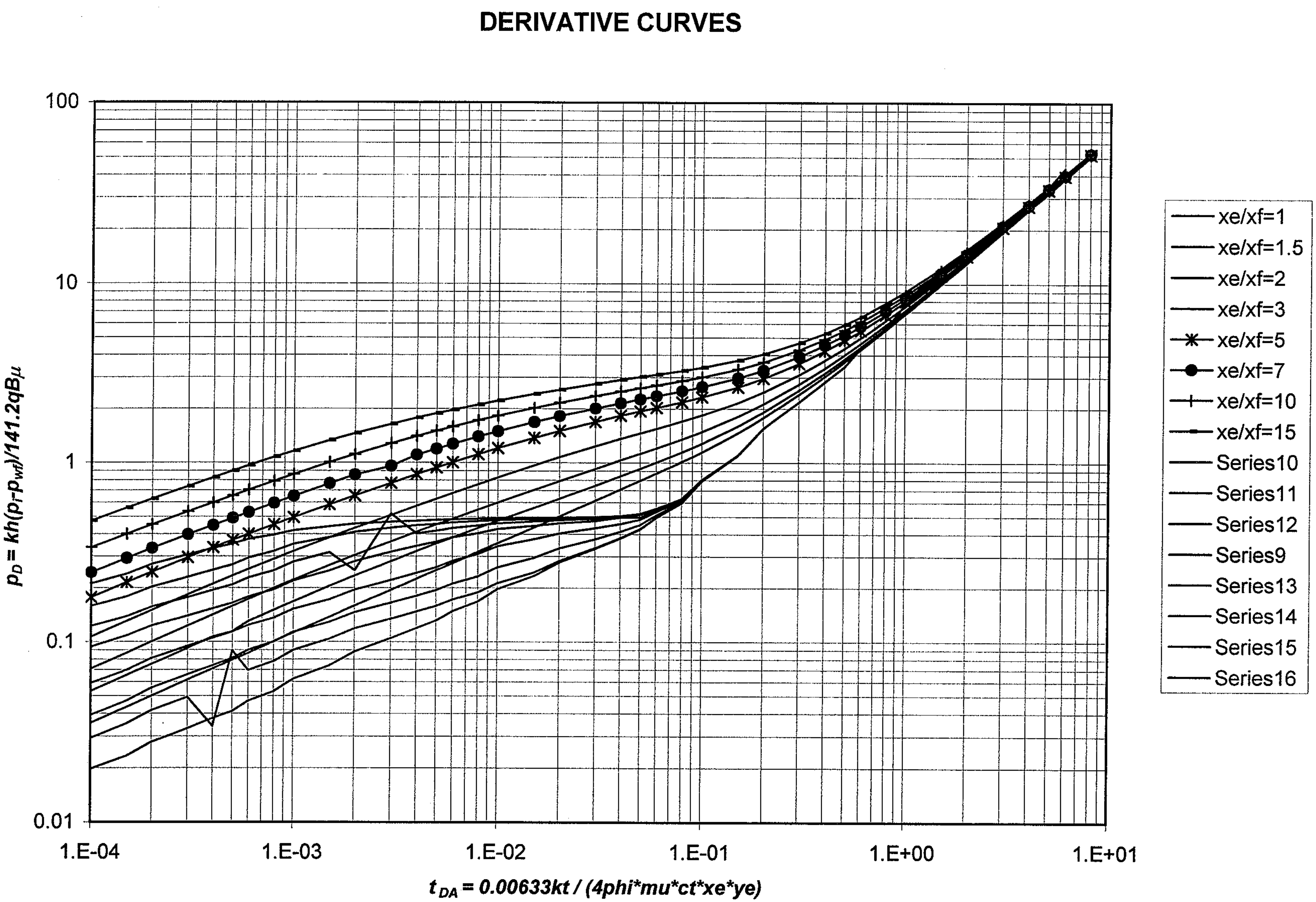
(a) Choose the t_{DA} plot and add derivative curves to it. You will have to add the derivative calculation to the calculation spreadsheet and add the derivative curves to the plot. Turn in printouts of your plot and enough of your calculation worksheet to see your calculations. Make your derivative curves solid black lines and label them by hand.

(b) Now make the following calculations for a particular well (see data below).

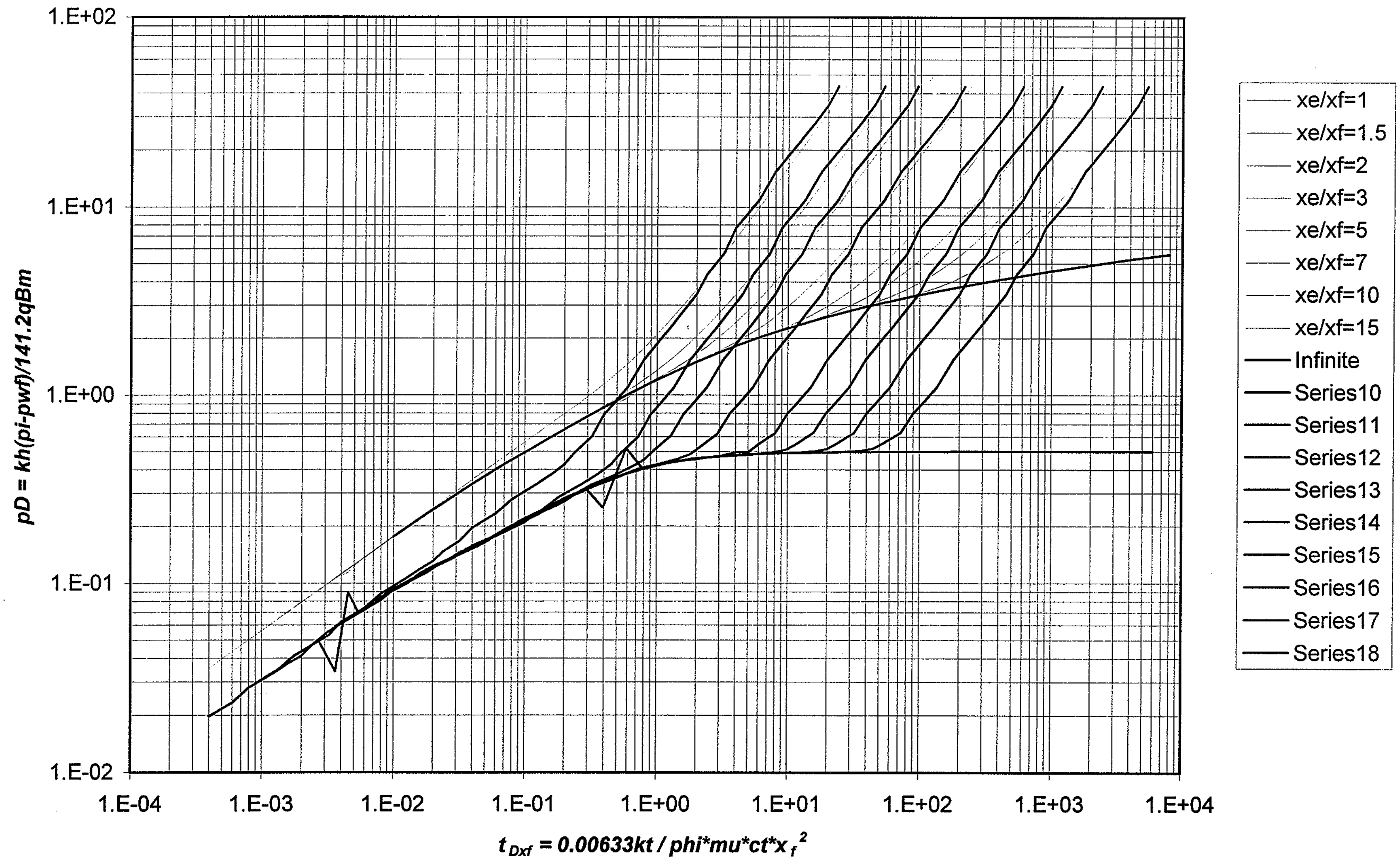
1. Δp at t = 10 days
2. Δp at t = 100 days
3. Δp at t = 1,000 days
4. Calculate the time (days) to the end of linear flow. (indicate the value of dimensionless time that you are reading from your plot).
5. Calculate the time (days) to begin PSS. (indicate the value of dimensionless time that you are reading from your plot).

Data:

Drainage area = 40 acres
x_e/x_f = 2
Permeability = 3.1 md
Net thickness = 120 ft
Porosity = 0.17
Viscosity = 10.5 cp
Total compressibility = 12 x 10^{-6} psi^{-1}
Formation volume factor = 1.05 RB/STB
Production rate = 85 STB/D
Initial pressure = 3,000 psig


DERIVATIVE CURVES
100
10
1
0.1
0.01
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
$p_D = kh(p_i-p_{wf})/141.2qB\mu$
t_{DA} = 0.00633kt / (4phi*mu*ct*xe*ye)
xe/xf=1
xe/xf=1.5
xe/xf=2
xe/xf=3
xe/xf=5
xe/xf=7
xe/xf=10
xe/xf=15
Series10
Series11
Series12
Series9
Series13
Series14
Series15
Series16

DERIVATIVE CURVES



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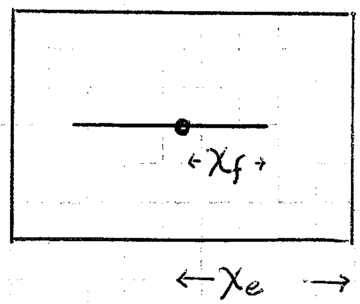
Part (b)

Reservoir Dimensions



$A = 40$ Acres

$A = 1{,}742{,}400\ ft^2$

$$A = (2x_e)^2$$

$$x_e = \frac{1}{2}\sqrt{A} = \frac{1}{2}\left(\sqrt{1{,}742{,}400\ ft^2}\right)$$

$$x_e = 660\ ft$$

$$\frac{x_e}{x_f} = 2$$

$$x_f = x_e/2 = 330\ ft$$

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Part (b)

1. ΔP at $t = 10$ days

$$t_{Dxf} = \frac{0.00633\, k\, t}{\phi\, \mu\, C_t\, x_f^2}$$

$$= \frac{0.00633\,(3.1\ md)(10\ day)}{(0.17)(10.5\ cp)(12\times10^{-6}\ psi^{-1})(330\ ft)^2}$$

$$= 0.084124$$

From Gringarten Type Curve Plot:

$$P_D = 0.45$$

$$P_c = \frac{k\,h}{141.2\, q B \mu} = \frac{(3.1\ md)(120\ ft)}{141.2\,(85\ stb/d)(1.05\ rb/stb)(10.5\ cp)}$$

$$= 0.002811$$

$$\Delta P = \frac{P_D}{P_c} = \frac{0.45}{0.002811}$$

$$= 160\ psi$$

3-0235 — 50 SHEETS — 5 SQUARES
3-0236 — 100 SHEETS — 5 SQUARES
3-0237 — 200 SHEETS — 5 SQUAR
3-0137 — 200 SHEETS — FILLER
COMET

Part b: cont'

2. ΔP at $t = 100$ days

$$t_{Dx_f} = \frac{0.00633\,(3.1)(100)}{(0.17)(10.5)(12\times10^{-6})(330)^2}$$

$$= 0.8412$$

From gringarten type curve

$$P_D = 1.2$$

$$\Delta P = \frac{P_D}{P_c} = \frac{1.2}{0.002811}$$

$$= 427 \text{ psi}$$

3. ΔP at $t = 1{,}000$ days

$$t_{Dx_f} = \frac{0.00633\,(3.1)(1{,}000)}{(0.17)(10.5)(12\times10^{-6})(330)^2}$$

$$= 8.412$$

From Gringarten Type curve:

$$P_D = 4.2$$

$$\Delta P = \frac{P_D}{P_c} = \frac{4.2}{0.002811}$$

$$= 1{,}494 \text{ psi}$$

Part (b)

4. Time to the END of linear flow.

From Gringarten Type Curve Plot:

End of linear flow is represented by the end of Straight line at:

$$t_{Dxf} = 0.04$$

$$t_{Dxf} = \frac{0.00633\ k\,t}{\phi\ \mu\ c_t\ x_f^2}$$

$$t = \frac{(0.04)(0.17)(10.5\,cp)(12\times10^{-6}\,psi^{-1})(330\,ft)^2}{0.00633\ (3.1\,md)}$$

$$t = 4.75\ day$$

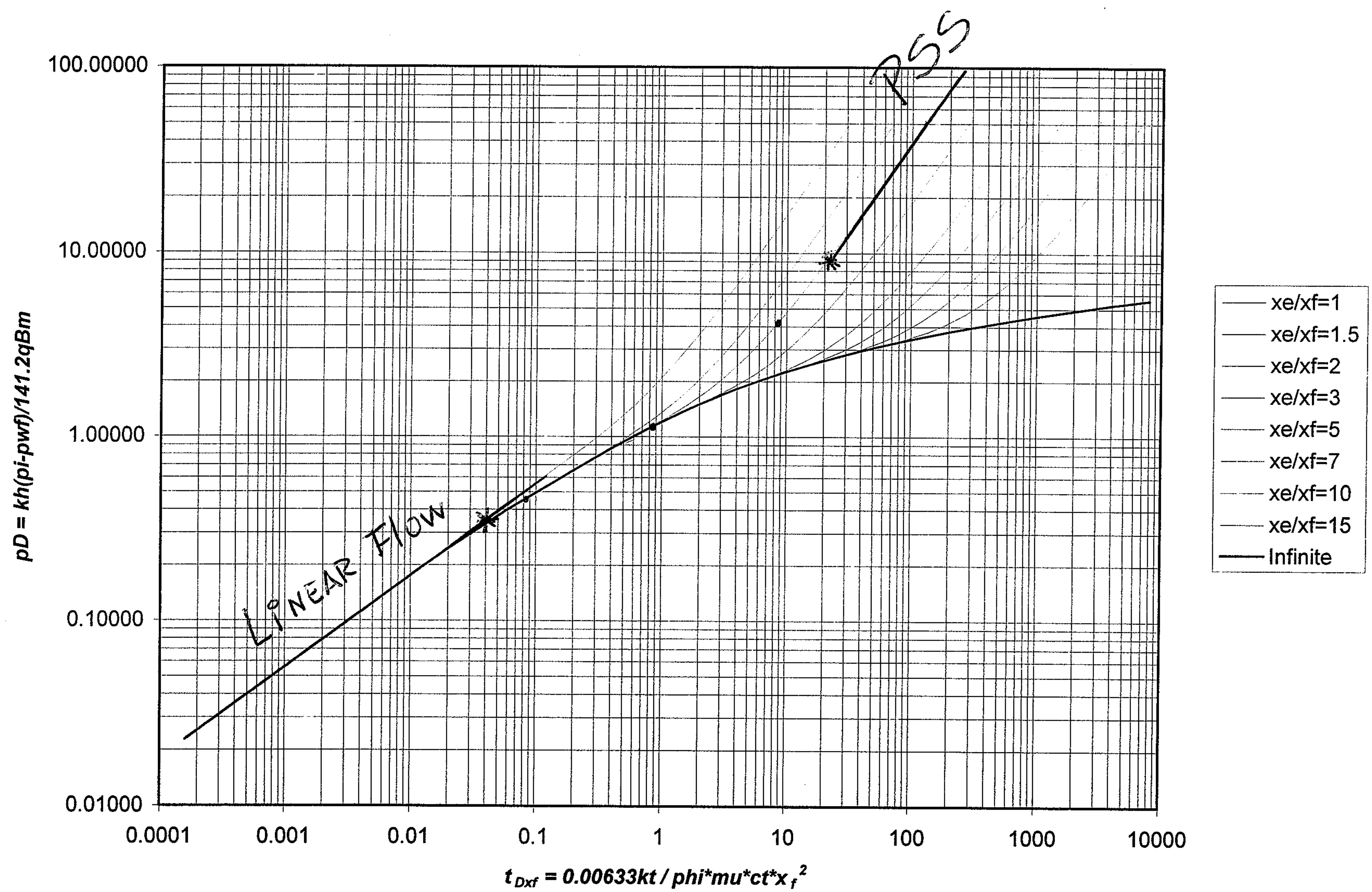
5. Time to begin PSS

From Gringarten Type Curve Plot:

$$t_{Dxf} = 23$$

$$t = \frac{(0.17)\ (23)(10.5)(12\times10^{-6})(330)}{0.00633\ (3.1)}$$

$$t = 2734\ days$$



100.00000
10.00000
1.00000
0.10000
0.01000
pD = kh(pi-pwf)/141.2qBm
0.0001
0.001
0.01
0.1
1
10
100
1000
10000
t Dxf = 0.00633kt / phi*mu*ct*x f 2
xe/xf=1
xe/xf=1.5
xe/xf=2
xe/xf=3
xe/xf=5
xe/xf=7
xe/xf=10
xe/xf=15
Infinite
LINEAR FLOW
PSS